

THE AMERICAN MINERALOGIST

JOURNAL OF THE MINERALOGICAL SOCIETY OF AMERICA

Vol. 28

MARCH, 1943

No. 3

SOME PETROLOGICAL CONCEPTS AND THE INTERIOR OF THE EARTH*

A. F. BUDDINGTON, *Princeton University, Princeton, New Jersey.*

INTRODUCTION

"A rock becomes alive to me only when I have grasped its relations to our planet and its history." This is a quotation from the writings of Rosenbusch, the founder of petrography, and it establishes a satisfactory precedent for the interest of petrologists in the interior of the earth.

Geochemists, geologists, and geophysicists have all drawn up hypotheses for the constitution and history of the interior of the earth, adjusted to fit the facts with which they are familiar and to take account of those interpretations and principles which seem most cogent to them. The result is a variety of earth models, seemingly sufficiently diverse and attractive to fit every taste. Certain pertinent concepts, however, have been developed in the field of petrology during the present century, and we may find it interesting and perhaps profitable to review and reconsider the problem more systematically in the light of these principles than has been done heretofore.

The concepts referred to are those of fractional crystallization, fractional melting, the *systematic* nature of the variation which the great thick mafic stratiform sheets such as the Bushveld, Duluth, and Stillwater have in common, and the necessity for providing a rational mechanism for the origin of such magmas as are considered primary, or in the words of Loewinson-Lessing, proto-magmas.

SURVEY OF 20TH CENTURY HYPOTHESES

We may first start with a quick survey of some 20th century hypotheses for the constitution of the interior of the earth.

The growth in detailed analysis by geophysicists of certain physical properties, such as the variation of the velocity of earthquake waves and of density with depth in the interior of the earth during the 20th

* Presidential address prepared for the twenty-third annual meeting of the Mineralogical Society of America. Due to the cancellation of the meeting the address was not delivered orally.

century, is portrayed in the series of representative models in the upper row of Figs. 1 and 2 while representative attempts to interpret these in terms of lithology are shown in the series of diagrams in the lower row.

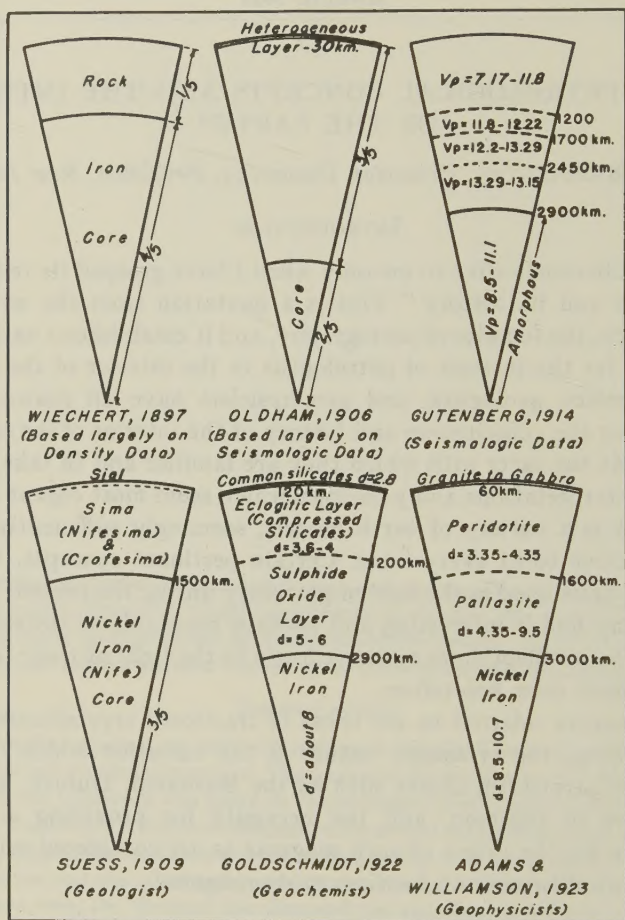


FIG. 1. Upper figures show geophysical data as interpreted by different authorities; lower figures show equivalent lithology as proposed by different men. d = density, Vp = velocity of compressional earthquake wave.

There is almost universal agreement that the most probable material forming the core of the earth is a nickel-iron comparable in character to the nickel-iron meteorites.

A thick sulphide-oxide layer is postulated by Goldschmidt on the basis of immiscibility of the sulphide melt with silicates and with nickel-iron, and gravity concentration of chromite, magnetite, ilmenite, etc. This has

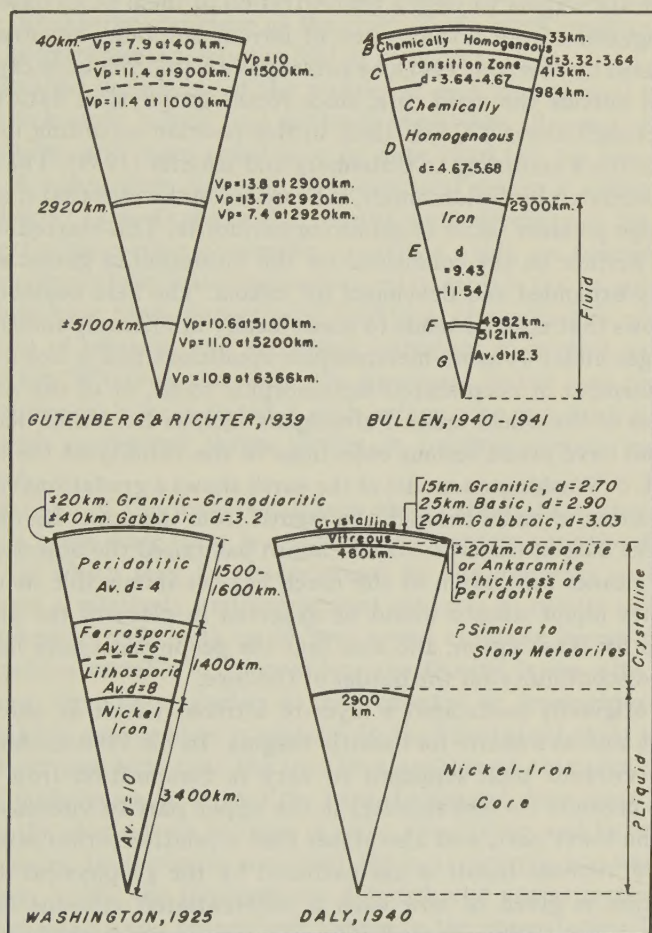


FIG. 2. Upper figures show geophysical data as interpreted by different authorities; lower figures show equivalent lithology as proposed by different men. d =density, V_p =velocity of compressional earthquake wave.

been criticized on the basis that it is improbable that so much sulphide exists in the earth, that if it does it should contain some metallic iron unless it also contains considerable alkali sulphide, and that trivalent

iron, such as is present in magnetite, would not be expected to form in such an environment. The criticism may also be made, by analogy with the mafic stratiform sheets, that as we shall see, magnetite and ilmenite would not be expected to crystallize at sufficiently early a stage from the mafic silicate magma to yield a concentration of them at its base. A *thin* as distinguished from a thick shell of ferrous sulphide, however, may, as suggested by Merwin (1941), be present as an amorphous or crystalline shell just outside the main core, since recent geophysical data indicate a distinct shell about 220 km. thick in this position according to Dahm, or 20 km. thick according to Gutenberg and Richter (1939). The eclogite layer, postulated by Goldschmidt, is based upon the idea that it is a deep seated high pressure facies of gabbro or peridotite. This started from the work of Fermor on the conditions for the formation of garnet and was especially expanded and developed by Eskola. The field evidence, however, shows that eclogite tends to occur locally in intensely folded mountain ranges under dynamo-metamorphic conditions and is not a characteristic member of deep seated metamorphic rocks, or of the Archaean complexes of the shield areas. Petrologists such as Backlund, Korjinsky and Dunn have raised serious objections to the validity of the concept.

The H. S. Washington model of the earth shows a gradational decrease in the content of metal through the mantle from the upper border of the core to the base of the crust. Goldschmidt has raised the objections that a much cleaner separation of the much heavier immiscible metal from the lighter liquid silicate would be expected in place of the gradation proposed by Washington, and also that the geophysical data indicate a sharper discontinuity for the border of the core.

Daly originally postulated a layer of vitreous basalt as one shell of the earth and as a source for basaltic magma. In his 1940 model he proposed a vitreous shell supposed to vary in composition from that of vitreous oceanite (or ankaramite) in the upper part to vitreous peridotite in the lower part, and also states that a relatively thin interrupted couche of vitreous basalt is not excluded by the geophysical data. No explanation is given of how such a differentiated vitreous shell was brought about. A vitreous shell of basaltic composition is still suggested by him as a possibility during former times.

MANNER OF VARIATION OF STRATIFORM SHEETS AND POSSIBLE ANALOGY FOR LAYERED STRUCTURE OF EARTH'S CRUST

At widely scattered localities in the world there are sheets of igneous rock which show a layered structure with certain systematic types of

variation. These sheets have great thickness, for example the Duluth, 1 to 9 miles thick; the Stillwater, 3 miles with the top not shown; the Bushveld, 2-3½ miles; and the Sierra Leone, about 4 miles thick with neither base nor top exposed. Here are examples of layered structures several miles thick of such character and origin that they may be analogous to the layered structure of the crust of the earth itself and which need to be extrapolated only ten fold or so to be as thick.

Our detailed knowledge of the manner of rock and mineral variation within thick mafic noritic and gabbroic sheets has all come within the 20th century, and more remains to be done than has yet been accomplished. A comparison, however, of the vertical sequence within the different sheets (Table 1) shows that despite much diversity in detail there are nevertheless certain systematic variations which are common to all. Numerous hypotheses have been advanced to explain the variation. Two major ones have been, respectively, fractional crystallization with gravity sorting of crystals, and successive intrusions of magma varying in composition. Whatever the cause, the significant fact is that repeatedly natural processes have operated in such fashion as to give thick stratiform sheets with superposed layers having in common certain systematic variations.

Comparison of the mafic stratiform sheets shows that, in a general way, on a gross scale there is a common systematic variation from the bottom up which may be characterized by the following rock types; at the base a relatively undifferentiated gabbroic or noritic chill facies, then ultramafic rocks with or without minor chromite layers, norite or olivine gabbro variable in composition, anorthositic layers with or without minor ilmenite-magnetite layers, quartz- or granophyre-bearing augite gabbro, granophyre or granite. In the Skaergaard sheet there are iron-rich ferrogabbros near the top. In a number of examples there are local sulphide lenses at or near the base. In general, from near the base upwards the plagioclases increase in soda, the olivines and hypersthene in iron, olivine diminishes to zero (with the local recurrence in some sheets at a higher level), the hypersthene diminish and augite increases, and interstitial quartz and granophyre appear in the upper facies. This is of course a very much simplified scheme for in detail there is a complex diversification within each of the mafic zones and often extensive small and moderate scale rhythmic repetition of rocks.

The position of ilmenite-magnetite layers in the upper part of some sheets have been thought by many to be anomalous and out of keeping with what might, a priori, be expected. The question may be raised as to whether the extent to which iron-rich layers *systematically* occur in the

TABLE 1. COMPARATIVE VERTICAL SEQUENCE IN SOME STRATIFORM SHEETS

	(1) DULUTH, MINNESOTA	(2) STILLWATER, MONTANA	(3) SKAERGAARD, GREENLAND	(4) BUSHVELD, AFRICA	(5) METEORITE EQUIVALENTS
Top	<i>Granophyre</i>	UNKNOWN	<i>Granophyre</i> <i>Ferrogabbros</i> Andesine, (An ₄₀₋₄₂) Hortonolite (F ₄₀₋₄₂) Ferroaugite, (Wo ₃₇ En ₂₁ Fs ₄₀) <i>Hypersthene-Olivine</i> <i>Gabbros</i> Labradorite (An ₆₀₋₆₂) Hyalosiderite, (Fs ₄₀₋₄₇) Hypersthene (En ₅₃₋₆₀)	<i>Granite</i>	? <i>Tekites</i>
Upper Part	<i>Olivine Gabbro</i> with anorthositic layers	<i>Gabbroic Zone</i> (5000-7000' ±) Local interstitial quartz Labradorite, An ₆₁ Augite (Wo ₄₁ En ₄₇ Fs ₁₀) Hypersthene (En ₅₀₋₇₀)		<i>Gabbro</i> , in part with interstitial Granophyre Labradorite (An ₆₀₋₆₂) Diopsidic Px	<i>Eucrite</i> (Pigeonitic), in part with interstitial tridymite or cristobalite Bytownite (An ₆₀₋₆₂) Pigeonite (Wo ₄₁ En ₄₇ - ₄₈ Fs ₁₀₋₄₀)
Above Central Part	<i>Olivine Gabbro</i> with <i>Anorthositic</i> (An ₇₂) and minor <i>ilmenite-magnetite</i> rich layers near central part	<i>Anorthositic Zone</i> (3500') Bytownite (An ₇₂₋₈₀) Hypersthene (En ₇₂₋₇₈) Augite (Wo ₄₁ En ₄₇ Fs ₁₂) Olivine (Fs ₁₀)		<i>Norite</i> , with <i>anorthositic</i> and minor <i>ilmenite-magnetite</i> layers Labradorite (An ₇₀₋₈₀) Hypersthene Diopsidic Px	<i>Eucrite</i> (<i>Hypersthene</i>) Bytownite (An ₇₂₋₈₀) Hypersthene (En ₇₂)
Below Central Part	<i>Olivine Gabbro</i>	<i>Noritic Layered Zone</i> (5000') Bytownite (An ₇₂₋₈₀) Hypersthene (En ₇₂₋₈₀) Augite (Wo ₄₁ En ₄₇ Fs ₁₀)		<i>Norite</i> , etc. Bytownite (An ₇₀₋₈₀) Hypersthene	
Lower Part	<i>Olivine Gabbro</i> with <i>Peridotite</i> layers	<i>Ultra Mafic Zone</i> (2500') Lab-Bytownite Enstatite (En ₈₄) Olivine (Fs ₁₀) Largely Saxonite and Bronzite with minor chromite layers		<i>Bronzite</i> with layers of <i>Peridotite</i> <i>Anorthositic</i> , <i>Norite</i> and <i>Dunite</i> with <i>ilmenite-chromite</i> layers Local Sulphide lenses	<i>Diogenites</i> Hypersthene (En ₇₂), (Bytownite) Roxides Hypersthene (En ₇₇), (Olivine) <i>Urtiles</i> Olivine (Fs ₁₇), (Hypersthene)
Chilled Facies	<i>Olivine Gabbro</i>	<i>Norite</i> (Chill Facies) Lab-Bytownite (An ₇₄) Hypersthene (En ₇₃) Dallage Local Sulphide Bodies	<i>Olivine Gabbro</i> Lab-Bytownite, An ₆₇ Diopsidic, Wo ₄₁ En ₄₇ Fs ₁₀ Hypersthene (En ₇₁) Olivine, Fs ₁₀	<i>Norite</i> Bytownite (An ₇₇) Hypersthene (En ₇₃)	<i>Olivine Eucrite</i> Bytownite (An ₇₃) Hypersthene (En ₇₃) Olivine

Based on data by Grout for (1), J. W. Peoples and H. H. Hess for (2), Wager and Deer for (3), and Hall and Lombaard for (4). The olivine eucrite of (5) is based on the normative composition of the average of achondrites.

upper part of stratiform sheets has been properly appreciated. It will be recalled, furthermore, that many petrologists have concluded that the course of crystallization of a basalt leads to a concentration of iron in the residual liquid. This conclusion may be qualified, at least for one course of differentiation and restated as follows: there is one course of differentiation of basalt and norite, or gabbro, which leads to a concentration of iron and titanium in the residual liquid up to a maximum in the later stages of consolidation, followed by a sharp decrease of these constituents and the development of a salic residuum. This course of differentiation is excellently shown in successive stages in the crystallization of certain basalts, for example, that of Aziro, Japan, described by Kuno, where the aggregate of phenocryst (29%) has the composition of a bytownite anorthosite, the crystalline groundmass (59%) the composition of a gabbro with practically all the iron and titanium, and the interstitial glass (12%) the composition of a quartz diorite with very little iron and titanium. Many intrusive anorthosite and gabbro masses, other than sheets, show successive intrusions of more mafic fractions including melanocratic bodies rich in ilmenite and magnetite or in hyalosiderite, or in all three as at Split Rock in the Adirondacks; Mine Hill, R. I.; Kusa, U.S.S.R.; and Susimäki, Finland. The data given by Wager and Deer for the Skaergaard sheet show that during the consolidation of 60 per cent of the gabbroic magma there was relatively little change in the composition of the residual liquid, that most of the iron and titanium crystallized after 75 per cent and before 95 per cent was crystalline, and that the granophyric residuum amounted to only 5 per cent. The iron-rich mineral in the Skaergaard mass is an olivine. As Wager and Deer point out, however, greater oxidation of the iron should produce early solid fractions relatively enriched in iron ore and magnesium-rich ferromagnesian minerals, and this would probably affect the proportion of feldspar in the magma in the middle and late stages. If the percentage of silica remains the same, metasilicates may be expected to form instead of orthosilicates where the iron is oxidized. Whether ferrogabbro layers rich in iron-olivine are alternative or successive to anorthosite with intercalated ilmenite-magnetite layers, is a problem, but in either case the course of diversification in mafic stratiform sheets commonly leads to a maximum concentration of iron and titanium at an intermediate or relatively late stage.

The data for the variation of the velocity of earthquake waves with depth in three different sections of the country, experimentally determined data for the velocity of earthquake waves in different kinds of rock, and a proposed arrangement of rock layers consistent with the geophysical data and with the arrangement in stratiform sheets is given

TABLE 2. STRUCTURE OF OUTER SHELL OF EARTH

Km. Depth	(a) New England (Leet)	(a) South- ern California (Guten- berg)	(e) E and NE of St. Louis (Walter and Birken- hauer)	PROPOSED EQUIVALENT ROCK LAYERS			
					<i>d</i>	<i>V_p</i>	<i>V_s</i>
0			(Sediments)	GRANITE-GRANODIORITE			
5	<i>V_p</i> —6.13 <i>V_s</i> —3.45	<i>V_p</i> —5.55 <i>V_s</i> —3.23	<i>V_p</i> —5.62 5 km. <i>V_p</i> —6.03 <i>V_s</i> —3.63	(b) Tishomingo, Okla. (b) Yosemite, Cal. (a) Quincy, Mass. (a) Rockport, Mass. (a) Tonalite, Val Verde, Cal. (c) Granodiorite	2.64 2.62 2.76 2.73	5.21 5.50 6.08 6.24 6.20	2.42 3.61 3.59 3.64 3.50
10		14 km.	13 km.				
15	16 km. 15 km.			QUARTZ GABBRO AND GABBRO			
20	<i>V_p</i> —6.77 <i>V_s</i> —3.93	<i>V_p</i> —6.05 <i>V_s</i> —3.39	<i>V_p</i> —6.33 <i>V_s</i> —3.74	(b) Quartz Gabbro-Norite, Sudbury (d) Quartz Dolerite, Whin Sill	2.937	6.22 6.34	3.49
25	29 km. <i>V_s</i> —4.27	25 km.	25 km.	(a) Quartz Norite, Sudbury	2.86	6.49	3.65
30	<i>V_p</i> —7.17 35 km.	<i>V_p</i> —6.83 <i>V_s</i> —3.66 31 km.	<i>V_p</i> —7.19 <i>V_s</i> —4.08	(f) ANORTHOSITIC (a) Stillwater, Mont. (Ab ₁₅ An ₈₅) (c) Plagioclase, Ab ₂ An ₇	2.74 2.715	7.06	3.68 3.96
35	36 km.	<i>V_p</i> —7.60 <i>V_s</i> —4.24	37 km.	NORITE OR OLIVINE GABBRO (a) Olivine Diabase, Vinal Haven (a) Hypersthene Gabbro, French Crk. (a) Feldspathic-Olivine Gabbro, Mellen	2.962 3.033 2.90	*7.20 *7.20 *7.45	3.88 3.98 3.71
40		39 km.		PYROXENITE (a) Bronzite, Bushveld (a) Bronzite, Stillwater	3.289 3.272	*7.90 7.83	4.55 4.58
45							
50	<i>V_p</i> —8.43 <i>V_s</i> —4.62	<i>V_p</i> —7.94 <i>V_s</i> —4.45	<i>V_p</i> —7.73 <i>V_s</i> —4.40	(g) PERIDOTITE AND DUNITE (a) Dunite, Balsam Gap, N.C.	3.275	*8.00	4.57
55							
60							
65							
70							
75	Probably a slight decrease in velocity of <i>V_p</i> at a depth of about 80 km. for a limited range of depth, below which it again increases with depth (Gutenberg & Richter, 1939).			PERIDOTITE, SEMIVITREOUS-VITREOUS, ENRICHED IN HYPERFUSIBLES			
80							
85							
90							

V_p—Velocity of primary earthquake wave in km. per sec.*V_s*—Velocity of secondary earthquake wave in km. per sec.*d*—Density.(a) Data from Handbook of Physical Constants. *Geol. Soc. Am., Sp. Paper 36*, pp. 80–82, 99 unless otherwise stated.(b) Field determinations for shallow depths, *Geol. Soc. Am., Special Paper 36*, p. 97.(c) From data by Adams and Williamson (1932), *Jour. Franklin Institute*, pp. 492 and 520, velocities for 10,000 megabars.(d) *Bull. Volcanologique*, Ser. II, Tome III, p. 47 (1938).(e) Walter, E. J., and Birkenhauer, H. F., *Trans. Am. Geoph. Union*, p. 406, (1941).

(f) With minor intercalated layers of ilmenite-magnetite.

(g) With minor intercalated layers of chromite and local sulphide lenses near base.

* Data for 900°C and pressure equivalent to depth of 40 km, Daly, *Architecture of the earth*, p. 55, (1938)

in Table 2. The major new feature introduced as compared with other models is the layer of bytownite-anorthosite. Ilmenite-magnetite layers or lenses up to a total of several score of feet in thickness may be intercalated in the anorthosite and chromite layers and lenses of similar aggregate in thickness may be associated with the peridotite and dunite. Local sulphide lenses may also be present in the latter ultramafic horizons.

NATURE AND VARIATIONS OF METEORITES

Analogy with the major kinds of meteorites has played so important a part in formulating our ideas concerning the nature of the interior of the earth that it is pertinent first to review their nature and the hypotheses as to the manner and cause of their variations. All the major types of meteorites are presented in Table 3. There are a number of additional kinds, but for several of these only a single specimen is known, and others, such as the mesosiderites, have been reasonably interpreted by Prior as one type injected by another so as to constitute a mechanical equivalent of our terrestrial migmatites. These are not included. Actually, nearly all types of meteorites are comprised within those chosen.

We may first see whether the manner of variation of the meteorites is amenable to interpretation as a product of fractional crystallization on the basis of our present data on the course of variation of composition arising from this cause.

TABLE 3. MAJOR MINERALS OF NORMATIVE COMPOSITION OF MOST MAJOR CLASSES OF METEORITES

METEORITE GROUP		Number of Analyses	Total Metal Fe+Ni	Molecular Ratio Fe/Ni in Metal	Molecular Ratio MgO/FeO in Silicates	Olivine	Hyperssthene	Diopside	Plagioclase	Free SiO ₂	Troilite	TERRESTRIAL EQUIVALENT OF SILICATES
ACHONDRITES												
(8) EUCRITES	A	9			0.7	—	43.1	15.8	37.0	1.44	.39	Bytownite quartz basalt
	B	2	.59		1.0	—	38.6	17.0	39.4	1.26	.64	Bytownite quartz basalt
	C	5			2.0	3.2	55.2	10.0	28.8	—	.50	Bytownite norite
(7) DIOGENITES		4			2.6	8.3	85.0	3.4	3.5	—	.37	Hypersthene
(6) RODITES		2			3.4	21.3	62.0	4.2	9.0	—	1.17	Saxonitic hypersthene
(5) UREILITES		2	7.10		5.0	68.8	18.7	2.7	1.7	—	.40	Saxonitic chrysolite dunite
CHONDRITES												
(3) SOKO-BANJA	A	5	2.8	5.2	1.7	68.2	6.0	5.0	7.6	—	5.2	Pyroxenic hyalosiderite dunite
	B	9	4.1	3.9	2.3	40.7	31.7	4.4	9.9	—	5.2	Chrysolite saxonite
(3) BAROTI		19	8.0	6.5	3.5	42.8	23.0	5.1	11.2	—	5.7	Chrysolite saxonite
(3) CRONSTAD		17	16.0	11.3	4.1	33.3	27.7	4.5	8.2	—	4.8	Chrysolite saxonite
(3) DANIELS KUL		4	21.4	12.0		1.4	53.8	3.2	8.8	—	8.4	Enstatolite
AVERAGE FOR GROUPS OF METEORITES												
(4) ACHONDRITES		26	.9		1.8	8.6	50.6	12.1	25.3	—	.6	Melanocratic bytownite norite
(3) CHONDRITES		77	11.6	9	2.8	45.5	20.9	4.2	11.2	—	5.5	Oligoclase saxonite
(2) PALLASITES		17	48.9	9	5.7	51.0					.03	Dunite
(1) SIDERITES		318	98.3	11							.12	

(1) Farrington (1911).

(2) Chirvinsky, *Min. Abst.* 2, 83 (1923).

(3) Based on data for fair to good analyses given by Prior (1916) and Farrington (1911).

(4) Average of achondrites listed plus Shergotty and Padvarnikai.

(5) Gopalpara and Novo Urei meteorites.

(6) Rodite (Raoult) and Elwell (Whitfield).

(7) Shalka (Av. of Rammelsberg and von Foulon), Manegaon (Maskelyne), Ibbenbuehren (vom Rath) and Tatouine (Raoult).

(8-c) Le Teilleul (Raoult), Frankfort (Mixer), Binda (Mingaye), Cachari (Ducloux) and Lubimowka (Doklady).

(8-b) Moore County (Henderson) and Macibini (v.d. Walt).

(8-a) Juvinas, Peramiho, Stannern Constantinople, Bereba (Raoult), Jonzac (Raoult), Petersburg, Pasamonte (Foshag) and Cachari (Ducloux).

ORIGIN OF VARIATIONS WITHIN CHONDRITIC METEORITES

We shall first consider the chondritic group of meteorites. The normative olivine of chondritic meteorites as given in Farrington's (1911) tables was plotted against the ratio of FeO to MgO in the olivine, and it is found that in general as the quantity of olivine increases in amount, the olivine itself is richer in fayalite, varying from forsterite of about $Fe_{0.85}$ in some of the olivine-poor Cronstad type to hyalosiderite of about $Fe_{0.63}$ in the very olivine-rich members of the Soko-Banja type. This is a relationship which is the opposite of that found in terrestrial stratiform sheets. The olivine occurring in concentrated masses in the stratiform sheets is the forsterite-rich olivine, whereas that in concentrated masses in the chondritic meteorites is a hyalosideritic type. In the members of the Soko-Banja meteoritic type, however, there is a wide range in the percentage of olivine present without a concomitant change in the fayalite content of the olivine, as though there had been sorting and local concentration of the hyalosiderite crystals.

Again, Chirvinsky has shown that the percentage of troilite is about constant in the chondrites and shows no correlation with the variation in the percentage of metal as would be expected if there had been any concentration by gravity.

In striking contrast to the iron-rich character of the olivine and pyroxene of the chondritic olivine-rich rocks, the pyroxene-rich chondritic rocks are enstatolites with an enstatite extraordinarily poor in iron. There is indeed a general increase in the percentage of magnesia in the pyroxene with an increase in the amount of pyroxene in the meteorite. This is the only major relationship which might be considered consistent with the idea of fractional crystallization.

The relationships between the concentration of olivine and its composition, and the constancy in amount of troilite, however, all tend to emphasize the inapplicability of the hypothesis of fractional crystallization to explain the mode of variation of composition of the chondritic meteorites.

Prior (1916) has made a systematic study of the chondritic meteorites and showed that for them, in general, with a decrease in the total amount of metal there is correlated an increase in the ratio of nickel to iron in the metal, and an increase in the ratio of FeO and MgO in the magnesian-silicates, as if there was a partition of the iron between the silicate and the metallic portions as a result of increasing oxidation. He drew the conclusion "that all meteorites have had a common origin from a single magma which is most nearly represented by that which gave rise to the Daniel's Kuil type of meteoric stone, and that from this magma all other

types have been produced by progressive oxidation of the nickeliferous iron." The Daniel's Kuil type of meteorite is predominantly enstatite and the reaction of ferrous oxide with enstatite would be expected to yield olivine and a pyroxene richer in iron, and a relationship whereby the olivine becomes richer in the fayalite molecule as the quantity of olivine increases. This gives a reasonable explanation for the relationships which actually obtain in the chondrites.

Prior has postulated that the achondrites, in general, represent a higher stage of oxidation than the chondritic meteorites. The achondrites average conspicuously higher in alumina and lime, and markedly poorer in sulphur and metallic iron than the chondrites, and the hypothesis that the former are the result of oxidation seems probable.

A striking contrast, however, is found in the mode of variation of composition within the chondritic and the achondritic meteorites, respectively. The variation within the chondrites is reasonably explained in terms of increasing degrees of oxidation, whereas the variations within the achondrites are not reasonably interpreted in terms of increasing degrees of oxidation but do have systematic relationships comparable to what would be expected from a process of fractional crystallization.

COMPARISON OF NATURE OF VARIATION IN ACHONDRITE METEORITES AND IN STRATIFORM SHEETS

The major types of achondrites comprise varieties similar to most major rock types found in thick stratiform mafic igneous sheets. If, as has been done in Table 1, we arrange the meteorite varieties in comparable order of superposition and compare in detail the manner of variation of their minerals from bottom to top, we find a surprising similarity to that which is found within the terrestrial sheets. For example, in both meteorites and terrestrial sheets the mafic minerals, olivine and hypersthene, become increasingly richer in the ratio of iron to magnesia from the dunitic rocks at the base to the basaltic or gabbroic facies near the top. Also, the monoclinic pyroxenes increase in quantity in the gabbroic rocks near the top in both cases, commonly pigeonite in the meteoritic eucrites and augite in the terrestrial gabbros. Cristobalite and tridymite occur as interstitial minerals in some eucrites as quartz occurs interstitially in some of the upper gabbros of stratiform sheets. There is also a relative concentration of ilmenite, magnetite, and apatite in the feldspathic rocks as compared with the ultramafics. So far as has been ascertained, however, the plagioclase of the meteorites does not become systematically of a more sodic variety in progressing from the ultramafic to the basaltic facies, as it does in most of the terrestrial bodies. The terrestrial Duluth sheet, however, is also reported to show little variation

in the composition of the bytownite plagioclase except in the uppermost felsic facies, though detailed study of this has yet to be made.

As might be expected, there are some meteorites whose relationship is doubtful. Chassignite is commonly classified as an achondrite. It is a hyalosiderite dunite and does not fit into the general pattern of the achondrites. Only one specimen has been described. The amphoterites (Jelica and Ibbenbüren) are commonly classified as achondrites. They have an oligoclase feldspar, however, and are grouped with the chondrites by La Croix. The augitic meteorites, El Nakhla and Angra, are also usually classed as achondrites but they too have a sodic plagioclase and only one meteorite of each type is known. The enstatolites such as Bishopville, Busti, Aubres, Shallowater, are classified as achondrites but do not fit appropriately into the scheme.

The composition of the chilled facies of the stratiform sheets, assumed to represent approximately the undifferentiated magma, differs from the average of the achondrites primarily in being over twice as rich in plagioclase (also somewhat more albitic); otherwise the two are similar. The more feldspathic nature of the terrestrial magma thus gives a reasonable explanation for the development of anorthosite layers in the stratiform sheets, whereas meteorites of the composition of anorthosite have never been found. The meteoritic eucrites, in general, at least in their later stages of consolidation also show characters indicative of relatively quick chilling, so that it is not intended to imply necessarily that they are unmodified fragments of the upper part of a stratiform body differentiated in place through fractional crystallization, but only that material of comparable composition may so have originated. Some of the ultramafic meteoritic achondrites, on the other hand, are coarse grained and may actually have originated as crystal accumulates. By analogy with the chromite layers of terrestrial rocks one might predict it possible that a meteorite with the composition of chromite may eventually be found, though because of its small volume the chances would be small.

The important point is that the achondrite meteorites whose average composition has been taken as equivalent to the upper part of the earth's mantle, show a kind of diversity which is consistent with the principles of fractional crystallization and gravity sorting as here assumed to be exemplified in the terrestrial stratiform sheets, and permits the hypothesis that the variations of stratiform sheets and of achondritic meteorites have had a fundamentally similar mode of origin.

A LAYERED EARTH SUITABLE FOR DERIVATION OF PRIMARY MAGMAS

The structure of the interior of the earth must be such that it will yield by some reasonable mechanism the primary magmas which have

been demonstrated to exist. Unfortunately petrologists are in wide disagreement as to how many and what are the primary as distinguished from secondary magmas. By primary magmas we here mean those derived by partial or complete melting of, or originating in, the primordial layers of the earth.

Daly has presented us with such convincing field evidence that basalt is a major primary magma, and Bowen, on the basis of the work of the Carnegie Geophysical Laboratory, has with a wealth of experimental data so logically and ingeniously shown how practically all types of igneous rock may theoretically be formed as secondary derivatives of basaltic magma, that the field evidence for the existence of other types of primary magma tends to be lost sight of or overshadowed.

However, such cogent evidence for the existence of primary magmas of the composition of peridotite and ultramafic rocks, of gabbroic anorthosite, as well as of quartz basalt on the one hand and of olivine or alkali-basalt on the other hand, has recently been presented (Hess 1938; Buddington 1939; Kennedy 1938) in detailed manner that the concepts are considered to warrant at least tentative acceptance without further discussion. We do not have an adequate thoroughgoing discussion of the hypothesis of possible pyroxenite magmas and for this reason they will not be considered. The initial magma for many of the great stratiform sheets was noritic. The proposal has been made that noritic magma originates from gabbroic magma, through the reaction with, and assimilation of, aluminous shales or schists. Adequate evidence that this has happened on so large and uniform a scale as required in each case is yet to be presented. It seems highly probable that a primordial norite zone lies at the base of the earth's gabbroic shell, and that primary norite magma would be derived therefrom. Parenthetically it may be noted that norite for some reason rarely appears as flows, in this particular being similar to anorthosite and peridotite. There appears to be no adequate basis for a decision at present as to whether a primordial granitic layer was formed, and if so, how thick. If present, its remelting would yield primary granitic magma.

The principles and results of fractional melting have not been investigated with the same intensity as those of fractional crystallization. One must exercise caution in attempting to apply directly to geological problems of the depths only such physico-chemical data as we now have, especially in view of the fact that there is considerable field evidence which at present cannot be strictly interpreted in terms of such solidus and liquidus relationships as have been experimentally determined for the common mineral compounds. Yet we may proceed to use these data to see what their implications would be.

Fractional or partial melting of the diverse primordial layers would be expected to yield a varied suite of primary magmas, interstitial and mechanically separable from the crystalline part, if melting does not proceed too far. Bowen (1928) has discussed in detail the derivation of gabbroic magma through the partial melting of peridotite. Similarly partial melting of pyroxenite or melanocratic norite would yield a noritic magma. Again, fractional melting of bytownite anorthosite to the proper degree would yield a gabbroic or noritic magma; further melting of such an anorthosite horizon would yield an andesine or labradorite gabbroic anorthosite magma without necessarily rendering the whole mass mobile. Partial melting of olivine gabbro would give a diorite magma, whereas quartz gabbro would give a quartz dioritic (andesitic) magma, and, as so adequately discussed by Eskola (1932), a granophyric gabbro would yield a small amount of primary granitic magma in the early stages of melting.

The problem of ultramafic magmas is a peculiarly enigmatic one and deserves especial consideration. It has been discussed by many. On the one hand we have the field evidence which appears to necessitate the hypothesis of ultramafic magmas as well as ultramafic crystal accumulates, and on the other hand the physico-chemical difficulties of understanding how there can be ultramafic magmas with the properties postulated by the field petrologist. H. H. Hess has recently (1938) discussed the problem and shown that the ultramafic magmas have a ratio of MgO/FeO of 9 or 10 to 1 in comparison to a ratio of 5 or 6 to 1 for the ultramafic crystal accumulate type from gabbroic or noritic magmas. In other words, the ultramafic magmas are richer in the higher melting component whereas the evidence is that their temperatures were actually lower than those of the gabbros and norites. Sosman (1938) has even suggested 600°C . as the temperature for an alkali peridotite dike at its site of emplacement.

Many petrologists, trying to get the temperature of ultramafic magmas as low as possible in order to facilitate their derivation, but mindful of the high melting point of forsterite-rich olivine have set the ultramafic magma temperatures as low as, but not lower than $1350^{\circ}\text{--}1500^{\circ}\text{C}$. for surface pressures, ($1500^{\circ}\text{--}1600^{\circ}$ for depth).

Daly (1940, p. 413) has postulated a vitreous peridotite layer at a depth of 80 km., more or less (Gutenberg 1939, p. 162 mentions 60–70 km.), which would have a temperature at complete melting of 1350°C . for surface pressures or 1590°C . at this depth.

This is unsatisfactory as it would presumably yield a magma at the place of intrusion with a temperature too hot to be consistent with the field evidence. The problem is to devise a mechanism for deriving a

magma of forsteritic composition with a temperature not exceptionally high. One approach to the problem that leads to an interesting result is to follow through an hypothesis such as follows for the history of development of the earth during its early stages.

TRIPARTITE DIFFERENTIATION ON LIQUEFACTION

We will adopt the hypothesis that the earth passed through a liquid stage by condensation from a gas. Data are not available to specify the exact course of differentiation during liquefaction and preceding the beginning of crystallization, but it is perhaps a not unreasonable speculation to assume that the product was a liquid mass consisting in a very rough way of a nickel-iron core surrounded by two successive largely silicate shells each varying in composition, but distinct as a whole from each other. The composition of the inner silicate shell was essentially comparable to a mixture of magnesian silicates and nickel-iron, like the pallasites and chondritic stony meteorites, with increasing degree of oxidation toward the outer border, while the second outer silicate shell represented the most intense stage of oxidation and was of noritic composition, analogous to but somewhat less melanocratic than the achondritic meteorites, and at most not over 50–70 km. thick. The two silicate shells did not become homogenized because of lack of time for diffusion to effect this, and convection currents would be restricted to the respective shells because of the contrast in densities. The contrasting character of the three major parts here proposed is paralleled by three groups of meteorites; the siderites, the pallasites and chondritic meteorites, and the achondrites, respectively. True transitional types between these three groups are effectively absent. Iron sulphide may have formed a fourth shell of minor thickness between the nickel-iron core and the inner silicate shell.

DIFFERENTIATION ON CRYSTALLIZATION

Crystallization succeeded the initial differentiation of the liquid phases and is assumed to have started at or near the base of the inner, ultra magnesian-rich silicate shell and gradually worked out toward the surface with some concomitant differentiation as a product of fractional crystallization and gravity sorting. This results at a late stage in a residual bipartite liquid shell, at most a few hundred kilometers thick, consisting of the outer primary shell of noritic magma overlying the remaining uncrystallized portion of the inner shell and now of peridotitic composition. It is postulated that crystallization is now initiated at the outer surface of the noritic shell which is the same as the surface of the earth itself and consolidation works inwards at the same time that consolida-

tion and growth of the peridotitic layer continues to increase outwards. Concomitant differentiation of the noritic shell yielded a primordial layered crust comparable to the stratiform sheets. At a certain stage of consolidation, while the solid peridotite and noritic differentiated layers are growing toward each other, the temperature of crystallization of the upper surface of the peridotitic shell will be reached and we will have the complex relationship of an upper and lower solid shell growing toward each other within the peridotitic zone, the upper peridotite layer at the same time acting as a false bottom for the differentiating noritic magma

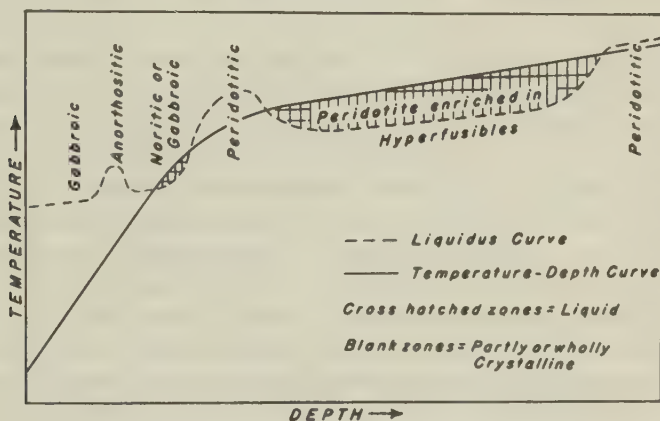


FIG. 3. Schematic diagram showing possibility for two liquid shells in outer part of earth at one stage of cooling. Blank areas between the two curves represent partly or wholly crystalline material.

shell above (Fig. 3). The crystallization of the peridotitic shell may be expected to result in a concentration of hyperfusibles (substances of low or exceptionally low melting temperatures, such as albite, water, etc.) within the last residual liquid fraction, and similarly there may be expected a concentration of hyperfusibles in the last part of the noritic shell to consolidate.

PERIDOTITE MAGMA RICH IN HYPERFUSIBLES

What would be the nature of the hyperfusibles in the peridotitic magma? The chondritic meteorites average about 10 per cent oligoclase. Some sodic compounds may well have been concentrated in the residual peridotitic magma. The processes of fractional crystallization and gravity sorting would probably result in an increase of ferrous iron relative to magnesia, and a MgO/FeO ratio in the peridotite somewhat less than that found by Hess for the ultramafic magmas. The probable percentage of volatiles and their nature is extremely speculative, but there seems

considerable basis for the validity of the concept of their concentration,

The nature of the dissolved gases does deserve some consideration. however, as it may be that they play a significant role in the formation of a forsterite-rich melt such as characterizes the ultramafic magmas. The principle that there is a qualitative similitude in the chemical composition of the sun, earth, and other members of the solar system is a currently accepted hypothesis. Hydrogen has been found to be a most important element quantitatively in the sun, stars, and the atmosphere of Jupiter and the larger planets. Russell (1942) estimates that on present data hydrogen forms at a minimum 35 per cent by weight and at a maximum 61 per cent of the sun, and that the sun now contains nearly as much helium as hydrogen. Hydrogen and carbon dioxide are the major constituents of the gases obtained at high temperatures from stony meteorites (Farrington, 1915) and Jaggar (1940), on the basis of studies of the composition of the gases in the liquid lava at Kilauea, has strongly urged the probable quantitative significance of hydrogen and carbon dioxide in primary magmatic gases. It is recognized, however, that the evidence for the presence of hydrogen as such instead of as compounds is suggestive only rather than proof. At the high temperatures assumed to prevail during the condensation of matter to form the earth, hydrogen would tend to escape from a mass of its size. Yet this would take time and it seems probable that some hydrogen would be dissolved and retained in the liquid mass of the earth. Part of this would in turn be subsequently lost, part may enter into reactions to yield new minerals but part would be expected to remain to be concentrated in the residual liquid peridotitic layer protected by the crystalline shell. This retained hydrogen could react with part of the ferrous iron of fayalite to yield a more forsterite-rich magma and a few per cent of bronzite and metallic iron. The latter would sink and rarely appear in an intrusive magma. Part of the hydrogen will become oxidized to H_2O .

Tamman (1924) has calculated that if the whole of the water, ice and snow at present on the earth were put back to the temperature we may imagine prevailing at the time when the earth was still hot and the crust had not formed, its vaporization would yield a partial pressure of water vapor of about 270 atmospheres and there would be enough water molecules dissociated to provide all the free oxygen at present in the earth's atmosphere. The earth during its condensation to a liquid would certainly have had an opportunity to dissolve gases under conditions of high gas pressure.

The proposed hypothesis would thus account for a residual layer of forsterite-rich olivine peridotite, at a relatively low temperature because of a high percentage of dissolved volatiles and other hyperfusibles, and

semi-vitreous to vitreous because it was at a temperature above that prevailing for the depth (Fig. 3).

If differentiation of the noritic shell yielded a granitic layer beneath an outer solidified gabbroic shell, the arrangement would be unstable, the granitic magma would flow to and rise through local fractured areas in the heavier overlying gabbro and the possibility for the segregation of continental-like sial masses would be initiated.

CONCLUSIONS

The preceding discussion of the nature of the interior of the earth has thus led to proposals for modification of current earth models whereby there is a layer of bytownite-anorthosite at or near a depth of 25 to 30 kilometers, and probably a relatively thin vitreous peridotitic or dunitic shell rich in hydrogen and other hyperfusibles beginning at a depth around 60–80 kilometers, of unknown thickness but not over a few hundred kilometers at a maximum and perhaps much thinner. The modified model thus proposed is shown in Fig. 4.

We may now proceed further and see what the consequences might be in the way of production of primary magmas from such an earth.

Kennedy and Anderson (1938) have given us a most stimulating discussion of how different kinds of magma may originate, dependent upon the interrelationship between the fusion curves for different types of rocks at their appropriate depths, and the temperature-depth curves. A modification and expansion of one of their diagrams constructed to fit the ideas developed here is given in Fig. 5. The temperature-depth curves will very likely have been different at different periods of earth history and in different structural units and will not have the smooth curve pictured. Local distortion may arise from the different conductivity of and different intensities of radio-thermal heating in different layers, and so forth. In orogenic belts there may be at least temporary thickening of the sial with a consequent local rise of the temperature in the upper part of the crust due to the multiplication of this relatively strong heating element. Also, if any of the sial is a product of subsequent differentiation during geologic time from the primordial layers, then the temperature curves would be modified thereby. Deformation of the earth layers will have essentially the effect of displacing the fusion curves for each rock layer with respect to the temperature-depth curve. A down fold for example would in effect shift them to the right. The curves may also be affected by the diffusion of hydrogen or perhaps other light molecules into the various rock layers from below. The relations shown in the diagram are such that when and where the temperature-depth curve is

raised relatively to and lies above the line (fusion curve) for the respective kind of rock, the appropriate magma will be formed.

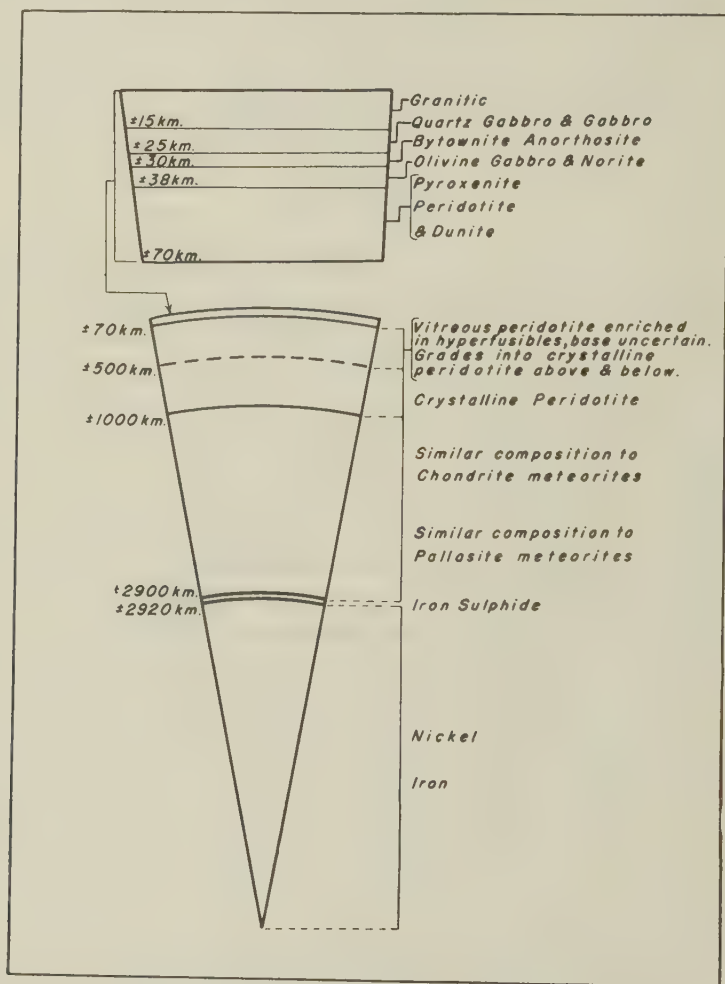


FIG. 4. Sector of earth beneath continents to illustrate proposed hypothesis for constitution of interior of the earth. Depths of shell boundaries are largely based on data by Gutenberg and Richter. The anorthosite zone may be expected to contain thin intercalated layers of ilmenite-magnetite, and the first (± 38 to ± 70 km.) peridotite and dunite zone thin layers of chromite and lenses of sulphide.

From the relationships shown we would anticipate that gabbroic (or basaltic) magma would be a dominant and recurrent type, inasmuch as it may form throughout such a very wide range of environment. A perido-

tite magma would be expected to rise only under exceptional structural dynamics. This is consistent with the evidence. An andesine or labradorite gabbroic anorthosite magma may originate through partial melting of bytownite anorthosite. The relationships of the anorthosite shell are such that anorthositic magma should also be expected to form only under extra exceptional conditions, and that melting sufficient to render the entire mass eruptible would scarcely occur. This is pre-eminently true, for rocks formed from intrusive anorthositic magma have been found almost exclusively in the pre-Cambrian and they are andesine

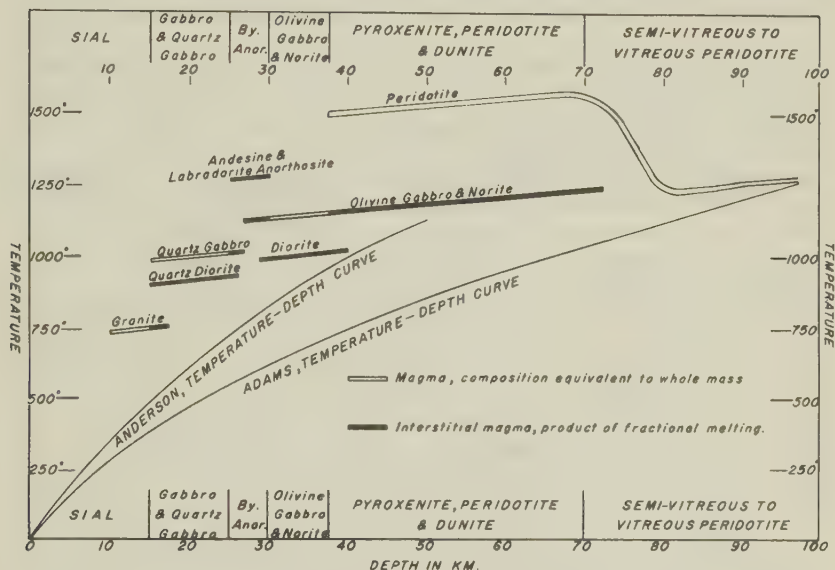


FIG. 5. Schematic fusion curves and temperature-depth curves to illustrate possible origin of primary magmas. Two temperature-depth curves are shown as proposed by their respective authors.

to labradorite types. It may also be noted that magmas derived by partial melting may be formed but once from a given mass for only the constituents of higher melting intervals remain as a residue. Again, we see that there are potentialities for the coexistence of two or more primary magmas of different compositions formed at different levels. Such primary magmas if injected at similar horizons in the crust would consolidate in the same order of succession as members of a magma series differentiated from a single common type and might give rise to a set of similar structural phenomena. The granitic magma derived from melting of the sial may, by definition, be primary only if part of the sial were primordial.

The picture postulated is admittedly highly speculative and schematic. Yet it may have value in emphasizing the possibilities for genesis and diversity of composition of primary magmas and for relating different types of magma to different structural dynamics.

SELECTED BIBLIOGRAPHY

- ADAMS, L. H., Temperatures at moderate depths within the earth: *Jour. Wash. Acad. Sci.*, **14**, 468 (1924).
- ADAMS, L. H., AND WILLIAMSON, E. D., Density distribution in the earth: *Jour. Wash. Acad. Sci.*, **13**, 413-428 (1923).
- BOWEN, N. L., The Evolution of the Igneous Rocks, 303-322 (1928).
- BUDDINGTON, A. F., Adirondack igneous rocks and their metamorphism: *Geol. Soc. Am., Mem.* **7**, 201-221 (1939).
- DALY, R. A., Igneous Rocks and the Depths of the Earth, pp. 173-239; 311-356. McGraw Hill, New York (1933).
- DALY, R. A., Strength and Structure of the Earth, pp. 1-21, 353-415 (1940).
- FARRINGTON, O. C., Meteorites (1915).
- GOLDSCHMIDT, V. M., Über die Massenverteilung im Erdinnern, verglichen mit der Struktur gewisser Meteoriten. Die Naturwissenschaften, Heft **42** (1922).
- GROUT, F. F., A type of igneous differentiation: *Jour. Geol.*, **26**, 626 (1918).
- GUTENBERG, BENO, Internal Constitution of the Earth. Physics of the Earth VII, McGraw Hill, New York (1939).
- GUTENBERG, BENO, AND RICHTER, C. F., On seismic waves: *Beitrag zur Geophysique*, **54**, 134-135 (1939).
- HALL, A. L., The Bushveld igneous complex of the Central Transvaal, South Africa: *Geol. Survey, Mem.* **28** (1932).
- HESS, H. H., A primary peridotite magma: *Am. Jour. Sci.*, **35**, 321-344 (1938).
- HOLMES, ARTHUR, The origin of igneous rocks: *Geol. Mag.*, **69**, 543-558 (1932).
- JAGGAR, T. A., Magmatic gases: *Am. Jour. Sci.*, **238**, 313-353 (1940).
- KENNEDY, W. Q., AND ANDERSON, E. M., Crustal layers and the origin of magmas: *Bull. du Volcanologique*, Ser. II, Tome **III**, 24-82 (1938).
- LOMBAARD, B. V., On the differentiation and relationships of the rocks of the Bushveld complex: *Geol. Soc. South Africa, Trans.* **37**, 5-52 (1934).
- MERWIN, H. E., General Geophysics, Chapter in 50th Anniversary Vol., *Geol. Soc. Am.*, **421** (1941).
- OLDHAM, R. D., Constitution of the interior of the earth: *Quart. Jour. Geol. Soc. London*, **62**, 456-473 (1906).
- PEOPLES, J. W., The geology of the Stillwater Igneous Complex: Doctorate dissertation, Princeton University.
- PRIOR, G. T., On the genetic relationship and classification of meteorites: *Mineral. Mag.*, **18**, 26-43 (1916).
- RUSSELL, H. N., The cosmical abundance of the elements: *Science*, 375-381 (1941). Present state of the theory of stellar evolution: *Scientific Monthly*, 236 (1942).
- SLICHTER, L. B., Cooling of the earth: *Bull. Geol. Soc. Am.*, **52**, 561-600 (1941).
- WAGER, L. R., AND DEER, W. A., The petrology of the Skaergaard intrusion, Kangerdlugssuaq, East Greenland: *Medd. om Grønland*, Bd. **105**, Nr. 4 (1939).
- WASHINGTON, H. S., Chemical composition of the earth: *Am. Jour. Sci.*, **9**, 351-378 (1925).

SYMPOSIUM ON DIAMONDS

(1) INTRODUCTORY STATEMENT

EDWARD H. KRAUS, *University of Michigan, Ann Arbor, Michigan.*

At the 1941 meeting of the Mineralogical Society of America held in Boston, the first symposium on diamonds was conducted. It was arranged because the greatly increased use of diamonds in industry, due largely to the war effort, prompted manufacturers and users of industrial diamonds to seek counsel and advice of mineralogists, who for the most part had given little attention to the industrial application of the mineral.

The participants in the symposium presented a large body of information concerning the production and the many uses of the diamond as a gem and in industry. The papers were published in the March 1942 issue of the *American Mineralogist** and attracted wide interest as is evidenced by the insistent and very gratifying demand for reprints in this country and abroad.

Pursuant to the desire expressed by those in attendance at the symposium, it was planned to arrange a similar program for the 1942 meeting of the Society to be held in Ottawa. Transportation and other difficulties, because of the war situation, made it necessary to cancel the annual meeting of the Society and consequently the symposium could not be held. It seemed wise, nevertheless, to secure brief statements concerning the changes and progress which had been made during the past year in production, the cutting of gem diamonds, diamond dies in the United States, diamond-set tools, and bonded diamond wheels from those who discussed these phases last year.

Because of the related character of the papers it has been deemed desirable that they should again be published together.

(2) DIAMOND PRODUCTION

SYDNEY H. BALL, *New York, N. Y.*

The world's diamond production, from 1940 to 1941, fell from over 14,250,000 carats to slightly under 9,350,000, a decrease of about 34 per cent. The major factor in the decrease was a fall of almost 4,800,000 carats in the Belgian Congo production, but most other districts showed decreases—the exceptions being the Gold Coast, Sierra Leone and South-West Africa. In 1942 the production presumably will approach that of 1941. Thereafter, if the war continues, a marked decline in production

* Pages 162-191.

may be expected, due to staff shortages and difficulties both in obtaining needed supplies and in shipping them to the remote regions in which the mines are situated. A number of the producing companies' engineers have signed up with the armed forces and replacements are impossible.

In 1941, industrial stones, mainly crushing bort, comprised 78 per cent of the production; in 1942, a slightly greater percentage, as the producing companies are pushing the exploitation of those mines which furnish a high percentage of industrial stones and relatively few gem stones. If the war continues, the relative percentage of industrials will continue to increase.

In 1941, by weight, Equatorial Africa (Congo, Gold Coast, Sierra Leone and Angola) accounted for 94 per cent of the production; South Africa and South-West Africa for two per cent; South America (Brazil, Venezuela and British Guiana), four per cent. The attempt by the Board of Economic Warfare to increase the production of other minerals in Minas Geraes, drawing their labor from the same pool, will presumably in 1942 result in a somewhat decreased diamond production in Brazil. As the African pipe mines were shut down (and are not likely to re-open for the duration), all diamonds are now derived from alluvial mines. Of the production of the African continent, two per cent came from gravels derived from Cretaceous pipes and 98 per cent from gravels derived from deposits of pre-Cambrian age. In 1941 the British Empire produced 20 per cent by weight (14.2 per cent in 1940) and 31 per cent by value (37.1 per cent in 1940) of that year's production. A single mine, Beceka, in the Belgian Congo, an extraordinary deposit both from its high diamond content and the size of its reserves, produced 58 per cent of the 1941 production.

Due to the tremendous increase in the use of the diamond in industry, it is fortunate that there are available to the United Nations considerable stocks above ground, for a few months hence demand will exceed current production. These stocks consist of relatively large surpluses in the hands of the Diamond Corporation and those in the hands of the producers not as yet delivered to the Corporation and, in addition, a healthy stock-pile here in America, divided in ownership between the government and industry. The United Nations are not short of diamonds, but certain finer grades have been scarce for four years, a potent reason to keep the mines in operation, since the finer industrial stones can only be produced as a small by-product of the run-of-the-mine output. Users must school themselves to employ poorer grades than formerly, and practice will show that these "inferior grades" will fulfill their mission admirably. It must be balm to Leon Henderson's heart that since the war began the price of industrial stones has been stabilized, thanks to the patriotism of

Sir Ernest Oppenheimer and the other directors of the Diamond Corporation, and of those of the producers.

The United Nations have, from the beginning of the war, had at their command the product of practically all the diamond mines of the world. A few months ago the mines of French Guinea fell into their lap and now Axis powers control only the Borneo mines, which account, in a normal year, for perhaps two one-hundredths of one per cent of the world's production. We understand that Germany is already woefully short of industrial diamonds and she is already using gem stones industrially. Japan also is in need of more diamonds, but since her citizens have only in relatively recent years appreciated the diamond, she has not many gem stones to fall back on. The shortage of industrial stones in the camp of the Axis powers can scarcely stop their war production; it may, however, slow it down appreciably.

We have previously emphasized that, of all the critical minerals and metals, the use of the diamond industrially is one of the most rapid in growth. This is particularly true of crushing bort. Many new companies have, in the past year, commenced to manufacture cutting wheels and other articles of which the cutting agent is diamond-dust bonded in a powdered metal or with a plastic. In consequence, the demand for crushing bort has doubled or quadrupled in the past year. The use of diamond dies and diamond-set tools has also greatly increased; that of diamonds in drilling has, on the other hand, fallen off, as prospecting, particularly in Canada, has slumped markedly since the war began. This loss to the bort market has been offset in part by the larger use of diamonds in blast-hole drilling. Nineteen forty-one saw the transfer of the diamond-die industry from France to the United States. Even after the war is over we will find industry demanding working diamonds in quantity.

War has, again, restricted the sale of "rough" suitable for gems, but so large have been the sales of industrial diamonds in 1942 that the Diamond Corporation will sell, in the year, more stones than in any year since 1937. The United States, however, continued to buy many gem diamonds, but due to the inroads on large fortunes, most sales were in the lower-price brackets. Prices of cut stones were firm.

(3) GEM DIAMONDS AND THEIR PRESENT TRENDS

LAZARE KAPLAN, *New York, N. Y.*

In recent years the diamond cutting industry has undergone great changes with a dispersal of the industry from Belgium, Holland, and Germany to the far corners of the earth. Diamond cutters are to be found in Transvaal, Palestine, Brazil, and Cuba, and the industry in Puerto

Rico and the United States has expanded more than ten fold. Prior to the war ninety-five per cent of the production of finished stones came from the Low Countries of Europe. No accurate information is available as to the extent of gem cutting in Europe today, but there is every indication that it is almost nil.

During 1941, much of the domestic demand was met by finished stones brought to this country by refugees. By the end of the year many of these refugees had found employment in the older cutting plants or in new establishments which sprang up in this country. The refugees tended to produce the same type of finished product that they cut in Europe. This changed the domestic picture from an industry devoted to the production of larger quality stones to one which produces all gradations of size and quality. In Palestine and Cuba, the newly established cutting plants are producing mainly single cuts (small, round stones with eighteen facets,—table, culet, eight top, and eight bottom facets). Some very fine single cuts are coming from Palestine. In Brazil and Transvaal the emphasis is upon the larger stones.

In this country non-union workers outnumber union workers by about two to one. The Union reported four hundred full-fledged workers and no apprentices in 1940, and in 1942, seven hundred in each category. It is interesting to note that among the apprentices there were fifty women. The women are being used to replace the men who have been called into the armed forces and it is believed that because of the time and money invested in training these women that they will be retained after the war. This assumes that the American industry will be able to compete as favorably with European labor in the production of fine quality large stones after the war as it did before the war. However, it is generally recognized that the cutting of small stones will cease in this country as soon as European competition must be met.

Government ceilings, both on wages and on prices of diamonds under one carat, have caused some dislocations in the industry. The ceiling on wages for any type of work is the highest salary paid to any worker in the shop for that kind of work on the effective date of the ruling. Hence, any shop employing even a single very highly skilled workman is able to outbid his less fortunate competitors. The cost of all imported "rough" has been raised five per cent since the passage of the act, but the producer is able to pass this increased cost on to the buyer only when the finished stone weighs one carat or more. Before the passage of the act there had been a disproportionate increase in the price of small stones over that of the larger stones. A considerable increase in the price of large stones is to be expected in the near future.

The scarcity of large "rough," plus the increased demand in war pro-

duction areas for jewelry will accentuate this tendency. Further, the inability of the jewelry trade to supply the retailer with those lines such as watches, which require priority materials, leads the jeweler to concentrate his sales efforts on diamonds. The high war-time marriage rate has brought an increased demand for engagement and marriage rings.

Many diamond cutting establishments which in the past have cut only gem diamonds have been called upon to produce specially shaped diamonds for tools, and for use in some types of instruments. The existing industrial diamond-cutting facilities have been unable to supply all of the greatly increased demand for such diamonds and it has been necessary to call upon the gem diamond cutters. The gem cutting branch of the industry will make every effort in the future to meet any demands that may be made upon it for shaped industrial diamonds.

(4) DIAMOND DIES

ALEXANDER SHAYNE, *New York, N. Y.*

During the past twelve months, under the guidance and encouragement of the War Production Board, considerable research work has been carried on in connection with improvement, not only in the quality of workmanship of fine sizes of diamond dies, but also in methods of their production.

The technique of drilling dies has improved greatly as the result of a frequent check of output by means of micro-photographic investigations which revealed flaws in processes and in the quality of workmanship.

Several concerns worked independently on their own development of machines. One of the most outstanding results achieved by one domestic company was caused by its bringing about semi-automatic machines for the drilling of the secondary cone approaching the bearing, and automatic machines for the final drilling of the bearing portion. This company has been honored with an Army-Navy "E" Award for its outstanding contribution in the quality and the quantity of its production.

With the assistance of these specially designed machines, the quantities of 0.0008"- to 0.0015"-size dies produced have increased from an average of under ten dies per month per operator, on conventional equipment, to approximately twenty dies per month per operator, representing an average reduction in labor consumption for all operations from twenty hours to ten hours per die.

While the methods of production of diamond dies were secretly kept by their respective companies—and this position was carefully safeguarded—the WPB, after assuring themselves of the reliability and of the great contribution made by the firm which produced the semi-automatic

and automatic machines, effected suitable financial arrangements for obtaining the rights to such machines so as to disseminate this information to all diamond die makers engaged in drilling dies below 0.0015". As a result, within a reasonably short time, diamond die makers may avail themselves of the best practices which have been developed in the U.S.A. for the production of diamond dies.

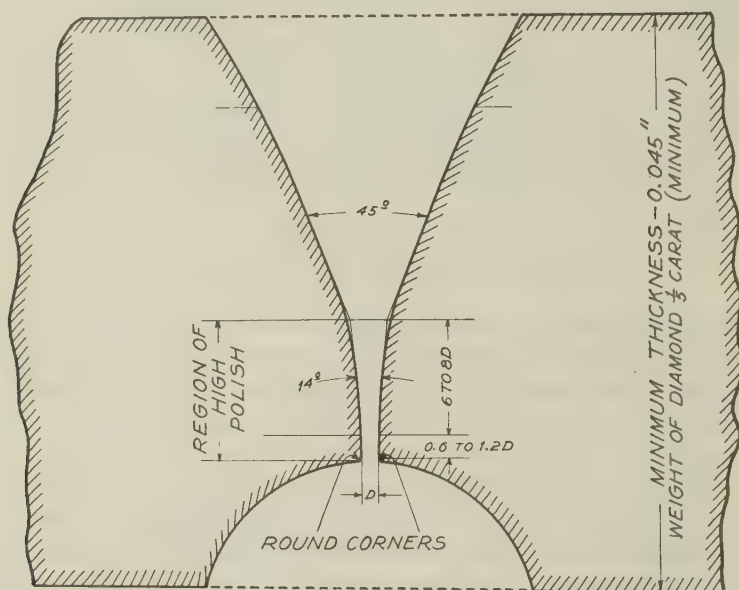


FIG. 1.

In order to establish the proper contours of diamond dies, large quantities of foreign-made dies were carefully analyzed by making numerous photographic enlargements thereof, which resulted in establishing the proper proportions of dies for the sizes under consideration, as shown in Fig. 1.

To aid further our domestic manufacturers, the WPB arranged to take numerous photographs of dies of their own production, as well as those of foreign creation. These photographs were demonstrated at the various plants for the benefit of the respective operators.

At random four representative photographs of diamond dies also have been selected to serve as illustrations in this paper.

Figure 1 indicates the ideal proportions of dies to be drilled. The length of the secondary cone, as well as the length of the bearing, is given in terms of the diameter of the wire which is to be drawn.

Figure 2. This die represents a pattern of an average good execution of a pre-war European die for drawing 0.0008" wire. The junction of the primary and secondary cones is gently blended. It also indicates the precise centering of the axis of the die bearing and the axis of the cones on either side of the die.



FIG. 2.

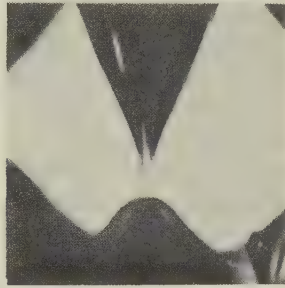


FIG. 3.

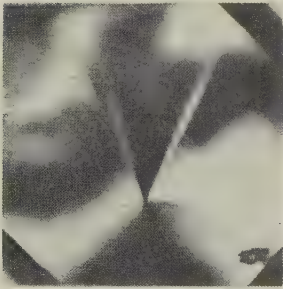


FIG. 4.



FIG. 5.

Figure 3. This die of 0.0008" size has been unusually painstakingly executed as to its shape and form. The polish in the secondary cone and throughout the bearing is excellent. The center of the cone, as well as the blending of the contours, is perfect. The shape and execution could be looked upon as a model of perfection.

Figure 4. This die, intended for 0.001" wire of early domestic production, is a typical die which lacks the secondary cone as well as the bearing. It is well centered but will not produce satisfactory wire and its life will be extremely short.

Figure 5. While this die has an excellent shape and shows proper blending between the primary and secondary cones, terminating into the bearing with a well centered cone on the back of the die, the pronounced

rings through the portion of the die where the plastic deformation takes place, are objectionable. While it is a well proportioned die, and is intended for 0.0008" wire, it will probably finish to 0.001" before the trace of the rings is eliminated.

It is very important that during drilling, proper considerations be given to the size of the grains of the diamond powder employed in drilling. It has been found that the drilling could start with grain sizes of about twenty microns. The polishing of the portion of the die where the plastic deformation of the wire takes place, and particularly the bearing portion, should be polished with diamond powder with grain sizes of approximately one to two microns.

The present facilities available in the United States are about equal to present minimum requirements, and expansion is rapidly taking place. We hope this will provide for maximum future requirements.

(5) DIAMOND-SET TOOLS

CHESTER B. SLAWSON, *University of Michigan, Ann Arbor, Michigan.*

There were no noteworthy developments during 1942 in the use of diamond-set tools. The industry itself was more interested in maintaining production levels to meet the increasing demands than in finding new uses for its products,

Wheel dressing tools, which consist of single uncut crystals mounted at the end of a steel shank, absorbed more of the larger sizes of stones than all other branches of the industry. Although the use of smaller stones mounted in a cast or sintered metal head for dressing wheels has been increasing, diamond core drilling consumes the major portion of these sizes. These two branches of the industry are fairly well stabilized and relatively speaking there is a fair degree of uniformity in the products of different manufacturers.

The future of the development of the diamond tool industry appears to lie in the production of shaped diamond tools for specialized purposes where the unusual properties of the diamond give it a preempted field. The greatest increase in the use of shaped diamond tools in 1942 was in cutting predetermined contours¹ in grinding wheels which in turn are used to grind the reverse contour. Various shaped "points" were developed to meet the increasing demand for this type of tool, especially, for use on thread grinding machines. These are often roughly lapped and do not require the high degree of skill necessary for the shaping of precision contoured wheels. While the surface is produced by lapping, it perhaps may be more aptly described as a refinement in bruting because it is

¹ Slawson, C. B., Diamond-Set Tools: *Am. Mineral.*, 27, 180 (1942).

done without reference to the grain of the diamond and is incapable of producing a high polish.

The production of a diamond tool with a predetermined contour is a refinement which calls for a higher degree of skill than the fashioning of gem stones. There are only a few cutters who are capable of producing a polished curved surface with a controlled radius.² The chief drawback to the wider use of these tools is their high initial cost, and the inability of most users to make minor repairs. These difficulties could be readily remedied if the tradition of secrecy and exclusiveness which has always surrounded diamond cutting were removed.

The widespread use of the diamond as a cutting tool is further retarded by the lack of knowledge on the part of the mechanic who uses the tool. The industry is still in its infancy and accordingly knowledge of the proper use of diamond-set tools is not widespread. The tendency has always been to use a diamond tool in the same manner in which a metal tool, or more recently a cemented tungsten carbide tool, is used. Today there are a number of specialized uses to which diamond tools are put because others are unsatisfactory. These include the turning of some of the harder woods, ivory, vulcanized rubber, plastics, and materials with a laminated construction. They are also used on many ceramic products and on all the metals except the ferrous alloys.

The statement is commonly made that diamond tools are unsatisfactory when used on the ferrous metals. This should be considered an open question until research proves that they are unsatisfactory at the speeds and feeds which are best adapted to the peculiar properties of the diamond. Further application of the diamond tool, not only in this field but in all others, will depend upon adequate research and the development of a body of common knowledge with respect to its use and abuse. The essential consideration to be borne in mind is that the diamond is a single crystal and not an aggregate of microscopic crystals as is the case with all other cutting materials.

(6) RECENT DEVELOPMENT OF BONDED DIAMOND WHEELS

A. A. KLEIN, *Norton Co., Worcester, Massachusetts.*

During the year 1942, the use of bonded diamond products in industry has expanded tremendously, both through the growth of the older applications and the development of newer applications. In our contribution to the symposium on Diamonds (*Am. Mineral.*, **27**, 185) a tabulation was given showing the relative production of diamond wheels from 1936

² Kraus, Edward H., and Slawson, Chester B., Cutting of diamonds for industrial purposes: *Am. Mineral.*, **26**, 154-155 (1941).

to 1941. With the 1936 production taken as 1, the 1941 output was given as 19. By the same comparison, the 1942 figure will reach 53. A brief summary is here given of applications other than that of shaping cemented carbide, which was quite fully discussed in the earlier paper.

The wider field for diamond wheels encompasses the grinding of exceedingly hard and brittle metals and non-metals. In preparing quartz for piezo-electric oscillators, metal-bonded diamond and diamond-impregnated metal wheels are used for the sectioning, trimming, dicing and grinding of these units, and resinoid wheels for finish-grinding the blanks to the desired thickness. The latter operation replaces the more laborious and time-consuming method of lapping with abrasive grain.

The rough grinding of Porro, angular and roof prisms is being done with metal-bonded wheels of a variety of shapes and sizes, and has allowed the manufacturers to introduce mass production methods in the fabrication of these units. It is interesting to note that for the first time in optical industry heavy machine tools for cylindrical grinding and surfacing have been employed in this connection.

The application of metal-bonded wheels as curved generators for the mass production of precision lenses meets the urgent need of our armed forces for such units as binoculars, range finders, and precision watch and optical units. These curved generators are being used for the roughing operation. In ceramics, metal-bonded wheels are being employed for precision finishing of fired ceramic bodies, involving internal, cylindrical and thread grinding, as well as grooving, and surfacing. Even structural brick is being cut commercially with bonded diamond cut-off wheels. Other noteworthy applications are in the internal grinding of cartridge and bullet dies made of Austenitic high-tungsten steel, and in the sectioning and finishing of synthetic sapphire boules for use as bearing jewels.

Finally, mention must be made of the considerable amount of time and attention given to the technology of bonded diamond products. This has resulted in improvements in the composition of metal bonds and in the manufacturing process for both metal and resinoid-bonded articles. A new and quite promising bond for diamonds is being developed. This bond is of the ceramic vitrified type with a high glass content. Vitrified-bonded diamond wheels appear to have some unique properties as compared with the older types.

MEMORIAL OF ARTHUR PHARAOH HONESS

W. M. MYERS,

The Pennsylvania State College, State College, Pennsylvania.

Dr. Arthur P. Honess, Professor of Mineralogy in the School of Mineral Industries at The Pennsylvania State College, died suddenly in the early morning of December 17, 1942. The previous day he had worked as usual completing the grades of students who had just finished the fall semester, and then attended the theatre that evening. The suddenness of his passing, although to be envied, was a stunning blow to his family, friends and students.

Arthur Pharaoh Honess was born August 10, 1887, in Berea, Ohio, the son of Pharaoh and Anna Riddles Honess. He displayed an interest in mineralogy at an early date in that famous sandstone-producing district. This interest undoubtedly was augmented by association with his older brother, Charles William Honess, who preceded him as a student at Oberlin and who continued the study of geology in various graduate schools, eventually adopting it as a profession.

After teaching for two years in the public schools of Indiana, Honess entered Oberlin College from which he graduated with the degree of A.B. in 1914. He then attended Princeton University from 1914 to 1917, serving as Assistant Mineralogist and receiving the degree of A.M. in 1916. At Princeton he studied under the late Dr. Alexander H. Phillips from whom he acquired an intense interest in crystallography and an affection for crystal forms which he retained permanently and passed on later to many of his students. His association with Professor Phillips was particularly happy and of major importance in guiding his career. In 1924 he received the degree of Doctor of Science from Princeton University.

Dr. Honess came to The Pennsylvania State College in 1917 as an instructor in mineralogy. This connection he continued until his death, passing through the ranks of assistant and associate to become full professor in 1931. Possibly the best criteria of the quality of his instruction are the records which his students have made in the graduate schools of other institutions and in a professional capacity. His enthusiastic interest in every phase of mineralogy was contagious and a continual inspiration to his students. His originality in presenting scientific data in the lecture room made facts unforgettable and was the source of delight to his audience. No labor was too great when expended in the assistance of an appreciative pupil, and he frequently exhausted himself in this service. His interest in students was not restricted to the classroom or laboratory but extended beyond these confines. He frequently aided students in the solution of personal problems which they would not confide to their



ARTHUR PHARAOH HONESS

1887-1942

regular faculty advisor. Many former pupils and associates will recall the unbounded hospitality of his home.

Dr. Honess became interested in the corrosion of crystals during his graduate study. The careful, painstaking research which he carried on in this field became the basis of one of the few publications dealing with the origin and interpretation of etch figures. "The Nature, Origin and Interpretation of the Etch Figures on Crystals" was published in 1927. He continued these investigations, using optically active solvents upon which he reported ten years later. This work in a field which has attracted but few investigators received widespread attention. In all research work he placed unusual emphasis upon the correct interpretation of observed data, a habit which he fixed in the minds of his students. His constant question was, "What does it mean?"

The first thorough petrographic study of the oil sands of Pennsylvania was carried out by Honess at a time when secondary recovery of petroleum, from sands previously considered exhausted, was being placed under scientific control. These studies made a substantial contribution to the knowledge of the mineral constituents of the rock and of the physical factors which control porosity and the behavior of the rock and its oil content when flooded. As a result of this study, methods employed in the preparation of samples for recovery tests were changed to conform with his recommendations. He also completed the first petrographic examination of the peridotite dikes of southwestern Pennsylvania and reported upon their significance. A similar interest in the bentonites of Pennsylvania resulted in an increase in data relative to their origin and geologic distribution. Honess was probably the first to observe the presence of authigenic albite in limestone in the United States, although he made no report of this observation until years later when it had been anticipated by the recorded observations of others.

The stimulation of his intellectual curiosity, his friendly concern for the troubles of others and his love for humor are missed by students and associates alike. He is survived by Mrs. Honess, a daughter Mary Ann, three brothers and one sister.

BIBLIOGRAPHY

1. On the etching figures of beryl: *Am. Jour. Sci.*, **43**, 223-236 (1917).
2. A study of the etching figures of the hexagonal alternating type of crystals: *Am. Mineral.*, **2**, 57-62 and 71-74 (1917).
3. The association of pyrite and stilbite in New Jersey: *Am. Mineral.*, **2**, 117 (1917).
4. On the etching figures of the dihexagonal alternating type of crystals: *Am. Jour. Sci.*, **45**, 201-218 (1918).
5. The etching figures of topaz: *Am. Mineral.*, **6**, 71-77, 1 fig., 1 pl. (1921).
6. Some interesting chalcedony pseudomorphs from Big Badlands, South Dakota: *Am. Jour. Sci.*, 5th Ser., **5**, 173-174 (1923).

7. Mineralogical analysis of Hagerstown silty clay loam soil: *Soil Science*, **15**, 10-12 (1923).
8. (And Graeber, C. K.), A new occurrence of an igneous dike in southwestern Pennsylvania: *Am. Jour. Sci.*, 5th Ser., **7**, 313-315 (1924).
9. (And Graeber, C. K.), Petrography of the mica peridotite dike at Dixonville, Pennsylvania: *Am. Jour. Sci.*, 5th Ser., **12**, 484-494, 6 figs. (1926).
10. The nature, origin, and interpretation of etch figures on crystals: xiii+171 pp., 95 figs., New York, John Wiley and Sons (1927).
11. (And Bonine, C. A.), Bentonite in Pennsylvania: *Penna. Acad. Sci., Proc.*, **3**, 18-25 (1929).
12. (And Graeber, C. K.), Petrography of the mica peridotite dike at Dixonville, Pa.: *Pennsylvania State College, Min. and Met. Exp. Sta., Bull.* **2**, 16 pp., 7 figs. (1926).
13. The theory of crystal etching and its significance in the classification of crystals: *Pennsylvania State College, M. I. Exp. Sta., Bull.* **3**, 8 pp., 3 pls. (1929).
14. A study of the microscopic characteristics of Pennsylvania oil sands, with special reference to porosity determinations: *Pennsylvania State College, M. I. Exp. Sta., Bull.* **9**, 27-46, 13 figs. (1930).
15. (And Heyl, G. R.), Further observations on temperature-porosity relations in oil sands: *Pennsylvania State College, M. I. Exp. Sta., Bull.* **11**, 93-104 (1932).
16. (And Williams, F. J.), Dickite from Pennsylvania: *Am. Mineral.*, **20**, 462-466 (1935); *Penn. State Coll. Min. Ind. Exp. Sta., Tech. Paper* **18** (1935).
17. (And Jones, J. R.), Etch figure investigations with optically active solvents: *Bull. Geol. Soc. Am.*, **48**, 667-722 (1937).
18. (And Jeffries, C. D.), Authigenic albite from the Lowville limestone at Bellefonte, Pennsylvania: *Jour. Sed. Petrology*, **10**, 12-18 (1940).
19. (With Krynine, P. D., and Myers, W. M.), Siliceous oolites and chemical sedimentation (abstract): *Bull. Geol. Soc. Am.*, **52**, 1916-1917 (1941).

MEMORIAL OF JOSEPH HYDE PRATT

JASPER L. STUCKEY,

The North Carolina Department of Conservation, Raleigh, North Carolina.

Joseph Hyde Pratt was born in Hartford, Connecticut, on February 3, 1870, the son of James Church and Jennie Abby (Peck) Pratt. He came from early colonial stock, his forbears having settled in New England about 1632. He died on June 2, 1942, in Chapel Hill, North Carolina, where he had made his home for forty-five years, and was buried in the cemetery there.

He received his early education in the Hartford Public High School and then attended the Sheffield Scientific School of Yale University, where he received the degree of Bachelor of Philosophy in 1893, and the degree of Doctor of Philosophy in 1896. As an undergraduate, his chief interest was in chemistry in which he made a brilliant record. In the summer of 1892, he went on a mineral collecting trip through western North Carolina with S. L. Penfield and J. A. Holmes, and this experience doubtless changed his chief interest from chemistry to mineralogy and geology. He served as laboratory assistant in chemistry at Yale during the year 1893-1894, and as a laboratory assistant in mineralogy during the years 1894-1896. He was instructor in mineralogy in the Harvard Summer School of 1895, and at Yale in 1896-1897.

In 1897, he came to North Carolina as State Mineralogist. He served as State Mineralogist from 1897 to 1906, and as State Geologist from 1906 to 1924. He was Lecturer in Mineralogy in the University of North Carolina from 1898 to 1904 and Professor of Economic Geology from 1904 to 1924. He also served as Assistant Field Geologist to the U. S. Geological Survey from 1899 to 1910, as a member of the International Jury of Awards at the St. Louis Exposition in 1904, as direction of briquetting experiments at the U. S. Geological Survey Coal Testing Plant at St. Louis in 1904-1905, as Chief of the Department of Mines and Metallurgy at the Jamestown Exposition in 1907, and as a special expert to the U. S. Twelfth Census on a number of minerals, among which were asbestos, barite, fluorspar, monazite, mica and talc, and soapstone.

During the period he served as State Mineralogist of North Carolina, his work was devoted almost entirely to mineralogy and geology, and he made many valuable contributions to the literature. He was the discoverer or co-discoverer of four new minerals, pirssonite, wellsite, rhodolite, and mitchellite. His method for the determination of ferrous iron in silicates is still a standard procedure. Early in his work as State Mineralogist, he became interested in the wide variety of gems and gem minerals in North Carolina, and for many years, until it was stolen, carried with



JOSEPH HYDE PRATT

1870-1942

him a small case of gems for demonstration purposes. At the Pan-American Exposition in Buffalo in 1901, and the Charleston Exposition in 1902, he was awarded diplomas and gold medals for his exhibits of North Carolina gems and gem minerals.

As State Mineralogist, Dr. Pratt had become interested in the conservation movement in the South. His appointment as State Geologist in 1906 made it possible for him to spend much of his time, without entirely neglecting geology and mineralogy, in conservation work. He was a pioneer advocate of good roads and worked incessantly for the passage of the Weeks Law authorizing the acquiring of land for National forests.

When the United States entered the war in 1917, he joined the military forces of his country and was commissioned a Major on April 24, 1917. He was assigned to the 105th Regiment of Engineers where he was promoted to Lieutenant Colonel on November 11, 1917, and Colonel on October 9, 1918. He served as Commander of the regiment and division engineer with the 30th Division in France from July 1918 to May 1919, and was at the front in the Ypres sector, Flanders and Belgium, and in the Somme offensive. He received the Distinguished Service Medal in recognition of his services in these actions.

After the war he returned home with impaired health from which he never recovered. Being unable to assume all his former duties, as State Geologist, he resigned the position in February 1924. Retirement as State Geologist did not mean that he was to stop work. From 1924 to 1933 he was engaged as Consulting Engineer when his health would permit. With improved health he served from 1933 to 1938 as engineer with the Civil Works Administration and the Resettlement Administration. During 1938 he served as engineer consultant to the U. S. Geological Survey and as senior engineer consultant during 1939 and 1940.

Dr. Pratt was a Fellow of the Geological Society of America, the Mineralogical Society of America, the American Association for the Advancement of Science, the American Chemical Society, the National Geographical Society and the American Geographical Society, a member of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the Mining and Metallurgical Society of America, the New York Academy of Sciences, the North Carolina Academy of Science and Sigma Xi.

In 1923, Yale University awarded him the Honorary M.A. degree in recognition of his achievements. He had been recommended and approved for the Honorary degree of Doctor of Engineering at the 1942 Commencement of the North Carolina State College of Agriculture and

Engineering, of the University of North Carolina, but his last illness prevented his being present to receive it.

Dr. Pratt was married to Mary Dicus Bayley of Springfield, Ohio, on April 5, 1899. One son, Joseph Hyde Pratt, Jr., now a physician at the Mayo Clinic in Rochester, Minnesota, was born to them. After the death of Mrs. Pratt, in 1929, Dr. Pratt was married on August 29, 1930, to Harriet White Peters of Baltimore, Maryland, and Washington, D. C. He is survived by Mrs. Pratt, one son, Joseph Hyde Pratt, Jr., and two step sons.

BIBLIOGRAPHY

- (With Penfield, S. L.), On the chemical composition of staurolite and the regular arrangement of its carbonaceous inclusions: *Am. Jour. Sci.*, series 3, **48**, 81-89 (1894). Also *Zeits. Kryst.*, **23**, 64-72 (1894).
- On the determination of ferrous iron in silicates: *Am. Jour. Sci.*, series 3, **48**, 149-151 (1894).
- Mineralogical notes on cerussite, calamine and zircon: *Am. Jour. Sci.*, series 3, **48**, 212-215 (1894).
- On double haloids of caesium, rubidium, sodium and lithium with thallium: *Am. Jour. Sci.*, series 3, **49**, 397-404 (1895).
- (With Penfield, S. L.), Effect of mutual replacement of manganese and iron on optical properties of lithiophilite and triphylite: *Am. Jour. Sci.*, series 3, **50**, 387-390 (1895). Also *Zeits. Kryst.*, **26**, 130-133 (1896).
- (With Penfield, S. L.), On the occurrence of thaumasite at West Paterson, New Jersey: *Am. Jour. Sci.*, series 4, **1**, 229-233 (1896). *Yale Bicentennial Publication*, Contributions to Mineralogy, 246-251 (1901).
- On northuptite; pirssonite, a new mineral; gaylussite and hanksite from Borax Lake, San Bernardino County, California: *Am. Jour. Sci.*, series 4, **2**, 123-135 (1896). Also *Zeits. Kryst.*, **27**, 416-429 (1896). *Yale Bicentennial Publication*, Contributions to Mineralogy, 261-274 (1901).
- (And Foote, H. W.), On wellsite, a new mineral (Clay County, North Carolina): *Am. Jour. Sci.*, series 4, **3**, 443-448 (1897). *Zeits. Kryst.*, **28**, 581-587 (1897). *Yale Bicentennial Publication*, Contributions to Mineralogy, 275-282 (1901).
- On the crystallography of Montana sapphires: *Am. Jour. Sci.*, series 4, **4**, 424-428 (1897).
- Notes of North Carolina minerals: *Jour. Elisha Mitchell Scientific Society*, **14**, 61-83 (1897).
- Mineralogical notes on cyanite, zircon and anorthite from North Carolina: *Am. Jour. Sci.*, series 4, **5**, 126-128 (1898).
- (With Hidden, W. E.), On rhodolite, a new variety of garnet: *Am. Jour. Sci.*, series 4, **5**, 294-296 (1898).
- Mineralogical notes on anthophyllite, enstatite, and beryl (emerald) from North Carolina: *Am. Jour. Sci.*, series 4, **5**, 429-432 (1898).
- On the origin of the corundum associated with the peridotites in North Carolina: *Am. Jour. Sci.*, series 4, **6**, 49-65, maps (1898).
- Occurrence, origin and chemical composition of chromite: (Abstract). *Annals, New York Acad. Sci.*, **11**, 489-490 (1898); also *Eng. and Min. Jour.*, **66**, 696 (1898).
- (With Hidden, W. E.), Twinned crystals of zircon from North Carolina: *Am. Jour. Sci.*, series 4, **6**, 323-326 (1898).
- (With Hidden, W. E.), On the associated minerals of rhodolite: *Am. Jour. Sci.*, series 4, **6**, 463-468 (1898).

- On the occurrence, origin and chemical composition of chromite: *Am. Jour. Sci.*, series 4, **7**, 281–286 (1899). Also *Am. Inst. Min. and Metall. Eng., Trans.*, **29**, 17–39 (1900).
- On the separation of alumina from molten magnas, and the formation of corundum: *Am. Jour. Sci.*, series 4, **8**, 227–231 (1899).
- On the crystallography of rubies from Macon County, North Carolina: *Mineral. Mag.*, **12**, 150–151 (1899). Also *Am. Jour. Sci.*, series 4, **8**, 379–381 (1899). Also in Judd, J. W., and Hidden, W. E., On a new mode of occurrence of ruby in North Carolina: *Am. Jour. Sci.*, series 4, **8**, 370–381 (1899).
- A mica vein: *Popular Science News*, **33**, 202–203 (1899).
- On two new occurrences of corundum in North Carolina: *Am. Jour. Sci.*, series 4, **10**, 295–298 (1900).
- The chromite deposits of North Carolina: *Eng. and Min. Jour.*, **70**, 190 (1900).
- Talc and pyrophyllite deposits of North Carolina: *North Carolina Geol. Sur.*, Economic Paper **3**, 29 pages (1900).
- The mining industry in North Carolina during 1899: *North Carolina Bur. Labor and Printing*, Thirteenth Annual Report, **1899**, Raleigh (1900), pages 304–315.
- The occurrence, origin and chemical composition of chromite, with especial reference to the North Carolina deposits: *Am. Inst. Min. Eng., Trans.*, **29**, 17–39 (1900).
- The occurrence and distribution of corundum in the United States: *U. S. Geol. Sur., Bull.* **180**, 98 pages (1901).
- The mining industry in North Carolina during 1900: *North Carolina Geol. Sur.*, Economic Paper **4**, 36 pages (1901).
- A peculiar iron of supposed meteoric origin, from Davidson County, North Carolina: *Jour. Elisha Mitchell Scientific Society*, **17**, 21–26 (1901).
- A new meteoric iron from Davidson County, North Carolina: (Abstract). *Science*, New Series, **13**, 900–901 (1901).
- The South Mountain gold region of North Carolina: *Min. and Metall.*, **24**, 108, 134–135 (1901).
- Tungsten, molybdenum, uranium and vanadium: *U. S. Geol. Sur.*, Annual Report **21**, part 6, 299–318 (1901). Also *U. S. Geol. Sur.*, Mineral Resources, **1900**, 257–265 (1901).
- Aluminum and bauxite: *U. S. Geol. Sur.*, Mineral Resources, **1900**, 229–231 (1901).
- Antimony: *U. S. Geol. Sur.*, Mineral Resources, **1900**, 251–255 (1901).
- Talc and soapstone: *U. S. Geol. Sur.*, Mineral Resources, **1900**, 779–786 (1901).
- Abrasive materials: *U. S. Geol. Sur.*, Mineral Resources, **1900**, 787–801 (1901).
- Asbestos: *U. S. Geol. Sur.*, Mineral Resources, **1900**, 861–868 (1901).
- Graphite: *U. S. Geol. Sur.*, Mineral Resources, **1900**, 875–877 (1901).
- Gems and gem mining in the South: *The Southland*, **1**, 1–5, 67–71, 118–122 (1901).
- Chromite or chromic iron ore: *U. S. Geol. Sur.*, Mineral Resources, **1900**, 897–898 (1901).
- Abrasives of the United States: *Min. and Metall.*, **24**, 347–351 (1901).
- A tour through the building (Buffalo Exposition): *Min. and Metall.*, **24**, 316–317 (1901).
- Notes on the mineral resources of Puerto Principe Province, Cuba: *Min. and Metall.*, **24**, 428–429 (1901).
- Arizona copper: *Min. and Metall.*, **24**, 491–494; 521–523; 613–615 (1901).
- A review of the chemical constitution of tourmaline as interpreted by Penfield, Foote and Clark: *Jour. Elisha Mitchell Scientific Society*, **17**, No. 2, 1–5 (1901).
- Gold deposits of Arizona: *Eng. and Min. Jour.*, **73**, 795–796 (1902).
- Gold mining in the southern Appalachians: *Eng. and Min. Jour.*, **74**, 241–242 (1902).
- Marble and talc in North Carolina: *Stone*, **24**, 145–149 (1902).
- Gold and silver mining in North Carolina: *Mineral Industry*, **10**, 299–300 (1902).

- The mining industry in North Carolina during 1901: *North Carolina Geol. Sur.*, Economic Paper 6, 103 pages (1902).
- Progress of the corundum industry: *Mineral Industry*, 10, 16 (1902).
- Abrasive materials: *U. S. Geol. Sur.*, Mineral Resources, 1901, 781-807 (1902).
- Asbestos: *U. S. Geol. Sur.*, Mineral Resources, 1901, 887-895 (1902).
- Barytes: *U. S. Geol. Sur.*, Mineral Resources, 1901, 915-919 (1902).
- Chromite or chromic iron ore: *U. S. Geol. Sur.*, Mineral Resources, 1901, 941-948 (1902).
- Monazite and zircon: *U. S. Geol. Sur.*, Mineral Resources, 1901, 949-954 (1902).
- Nickel and cobalt: *U. S. Geol. Sur.*, Mineral Resources, 1901, 241-250 (1902).
- Talc and soapstone: *U. S. Geol. Sur.*, Mineral Resources, 1901, 773-780 (1902).
- Mica: *U. S. Geol. Sur.*, Mineral Resources, 1901, 873-878 (1902).
- Lithium: *U. S. Geol. Sur.*, Mineral Resources, 1901, 239-240 (1902).
- Fluorspar and cryolite: *U. S. Geol. Sur.*, Mineral Resources, 1901, 879-885 (1902).
- Strontium ores: *U. S. Geol. Sur.*, Mineral Resources, 1901, 955-958 (1902).
- Corundum in North Carolina and Georgia: *Scientific American Supplement*, 53, 22110 (1902).
- Tungsten, molybdenum, uranium and vanadium: *U. S. Geol. Sur.*, Mineral Resources, 1901, 261-270 (1902).
- Building stones of North Carolina: *Stone*, 27, 147-148 (1903).
- Progress of the corundum industry: *Mineral Industry*, 11, 16-17 (1903).
- Gold and silver mining in North Carolina: *Mineral Industry*, 11, 263 (1903).
- (And Sterrett, D. B.), The tin deposits of the Carolinas: *North Carolina Geol. Sur.*, Bull. 19, 64 pages (1904).
- The mining industry in North Carolina during 1902: *North Carolina Geol. Sur.*, Economic Paper 7, 27 pages (1904).
- The mining industry in North Carolina during 1903: *North Carolina Geol. Sur.*, Economic Paper 8, 74 pages (1904).
- Tungsten, molybdenum, uranium and vanadium: *U. S. Geol. Sur.*, Mineral Resources, 1902, 285-288 (1904).
- Talc and soapstone: *U. S. Geol. Sur.*, Mineral Resources, 1902, 867-872; 1903, 979-987 (1904).
- Abrasive materials: *U. S. Geol. Sur.*, Mineral Resources, 1902, 873-890; 1903, 989-1015 (1904).
- Asbestos: *U. S. Geol. Sur.*, Mineral Resources, 1902, 963-966; 1903, 1111-1116 (1904).
- Graphite: *U. S. Geol. Sur.*, Mineral Resources, 1903, 1121-1129 (1904).
- Nickel and cobalt: *U. S. Geol. Sur.*, Mineral Resources, 1902, 263-270 (1904).
- Lithium: *U. S. Geol. Sur.*, Mineral Resources, 1902, 259-261; 1903, 313-315 (1904).
- Fluorspar and cryolite: *U. S. Geol. Sur.*, Mineral Resources, 1902, 899-902; 1903, 1029-1032 (1904).
- Barytes: *U. S. Geol. Sur.*, Mineral Resources, 1902, 945-948; 1903, 1089-1094 (1904).
- Chromite or chromic iron ore: *U. S. Geol. Sur.*, Mineral Resources, 1902, 967-969 (1904).
- Monazite and zircon: *U. S. Geol. Sur.*, Mineral Resources, 1902, 1003-1006; 1903, 1163-1170 (1904).
- Sulphur and pyrite: *U. S. Geol. Sur.*, Mineral Resources, 1903, 1083-1087 (1904).
- (With Struthers, J.), Tin: *U. S. Geol. Sur.*, Mineral Resources, 1903, 335-349 (1904).
- Analysis of North Carolina titanite iron ore: *U. S. Geol. Sur.*, Mineral Resources, 1903, 310 (1904).
- Mineral paints: *U. S. Geol. Sur.*, Mineral Resources, 1903, 1095-1110 (1904).
- Steel hardening metals: *U. S. Geol. Sur.*, Mineral Resources, 1903, 285-310 (1904). Also issued as pamphlet of 30 pages (title slightly different) by Government Printing Office, Washington, D. C.

- Report on the property of the Person Consolidated Copper and Gold Mine Company, situated in Person County, North Carolina: 18 pages, no publication data (1904).
- (And Lewis, J. V.), Corundum and the peridotites of Western North Carolina: *North Carolina Geol. Sur.*, **1**, 464 pages, maps (1905). Abstract by authors *Geol. Centralbl.*, **8**, 487-492 (1905).
- Arizona asbestos deposits: *Mining World*, **23**, 17 (1905).
- The graphite industry: *Mining World*, **23**, 64-66 (1905).
- The mining industry in North Carolina during 1904: *North Carolina Geol. Sur.*, Economic Paper **9**, 95 pages (1905).
- The Southern Appalachian forest reserve: *Jour. Elisha Mitchell Scientific Society*, **21**, 156-164 (1905).
- Tin: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 377-380 (1905).
- Talc and soapstone: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 989-994 (1905). Also *U. S. Twelfth Census*, Special Report, *Mines and Quarries*, 1061-1065 (1905).
- Abrasive materials: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 995-1015 (1905). Also *U. S. Twelfth Census*, Special Report, *Mines and Quarries*, 878-879 (1905).
- Asbestos: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 1125-1142 (1905). Also *U. S. Twelfth Census*, Special Report, *Mines and Quarries*, 971-974 (1905).
- Graphite: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 1157-1167 (1905).
- Mica: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 1175-1184 (1905). Also *U. S. Twelfth Census*, Special Report, *Mines and Quarries*, 1029-1033 (1905).
- Lithium: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 361-362 (1905). Also *U. S. Twelfth Census*, Special Report, *Mines and Quarries*, 1021-1022 (1905).
- Fluorspar and cryolite: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 1031-1036 (1905).
- Barytes: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 1095-1102 (1905). Also *U. S. Twelfth Census*, Special Report, *Mines and Quarries*, 945-949 (1905).
- Sulphur and pyrite: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 1079-1094 (1905).
- Mineral for the manufacture of electric and gas lamps: *Mining Magazine*, **12**, 152-153 (1905).
- Steel hardening metals: *Scientific American Supplement*, **59**, 24594-24595 (1905).
- Monazite and zircon: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 1095-1102 (1905).
- Production of monazite, zircon, gadolinite and columbite or tantalum minerals: *U. S. Twelfth Census*, Special Report, *Mines and Quarries*, 1037-1039 (1905).
- Steel and iron hardening metals: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 301-358 (1905).
- Steel hardening metals: *U. S. Twelfth Census*, Special Report, *Mines and Quarries*, 963-967 (1905).
- Mineral paints: *U. S. Geol. Sur.*, Mineral Resources, **1904**, 1103-1119 (1905).
- Briquetting tests: *U. S. Geol. Sur.*, *Bull.* **261**, 134-168 (1905).
- Fluorspar: *U. S. Twelfth Census*, Special Report, *Mines and Quarries*, 897-899 (1905).
- Corundum and its occurrence and distribution in the United States: *U. S. Geol. Sur.*, *Bull.* **269**, 175 pages (1906).
- The cement gold ores of Deadwood, Black Hills, South Dakota: *Jour. Elisha Mitchell Scientific Society*, **22**, 23-27 (1906).
- The building and ornamental stones of North Carolina; a review. *Jour. Elisha Mitchell Scientific Society*, **22**, 63-79 (1906).
- Talc and soapstone: *U. S. Geol. Sur.*, Mineral Resources, **1905**, 1361-1368 (1906).
- Abrasive materials: *U. S. Geol. Sur.*, Mineral Resources, **1905**, 1069-1085 (1906).
- Monazite and zircon: *U. S. Geol. Sur.*, Mineral Resources, **1905**, 1313-1317 (1906).
- Report of committee on fisheries in North Carolina: *North Carolina Geol. Sur.*, Economic Paper **13**, 78 pages (1906).
- Steel hardening metals: *U. S. Geol. Sur.*, Mineral Resources, **1905**, 405-421 (1906).

- Briquetting tests: *U. S. Geol. Sur., Prof. Paper* **48**, Part 3, 1389-1459 (1906).
- Biennial Report of the State Geologist for years 1905-1906: *North Carolina Geol. Sur.*, 58 pages (1907).
- The mining industry in North Carolina during 1905: *North Carolina Geol. Sur.*, Economic Paper **11**, 96 pages (1907).
- The mining industry in North Carolina during 1906: *North Carolina Geol. Sur.*, Economic Paper **14**, 144 pages (1907).
- Mining in North Carolina in 1906: *Mining World*, **26**, 155-156 (1907).
- (And Steel, A. A.), Recent changes in gold mining in North Carolina that have favorably affected this industry: *Jour. Elisha Mitchell Scientific Society*, **23**, 108-133 (1907).
- Monazite in the Carolinas: *Mineral Industry*, **16**, 126-227 (1907).
- (And Sterrett, D. B.), Monazite and monazite mining in the Carolinas: *Jour. Elisha Mitchell Scientific Society*, **24**, 61-86 (1908).
- The mining industry in North Carolina during 1907: *North Carolina Geol. and Ec. Sur.*, Economic Paper **15**, 176 pages (1908).
- Mica Mining in North Carolina: *Mineral Industry*, **16**, 713 (1908).
- Minor mineral products of North Carolina: *Eng. and Min. Jour.*, **86**, 321 (1908).
- Production of mica in North Carolina: *Eng. and Min. Jour.*, **86**, 94 (1908).
- Proceedings of drainage convention held at New Bern, North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper **17**, 94 pages (1908).
- Report of convention called by Governor R. B. Glenn to investigate the fishing industries in North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper **16**, 45 pages (1908).
- Investigations of the North Carolina Geological and Economic Survey relating to forestry problems along the North Carolina banks: *Jour. Elisha Mitchell Scientific Society*, **24**, 125-138 (1908).
- Reforestation of North Carolina farm lands: *Manufacturers Record*, **54**, No. 16, 47-48 (1908).
- New occurrence of monazite in North Carolina: *Jour. Elisha Mitchell Scientific Society*, **25**, 74-77 (1909).
- (And Sterrett, D. B.), Monazite and monazite mining in the Carolinas: *Am. Inst. Min. and Metall. Eng., Bull.* **30**, 483-511 (1909). Also *Trans.*, **40**, 313-340 (1910).
- Peat and swamp lands: *Jour. Am. Peat Soc.*, **2**, 13-17 (1909).
- (And Sterrett, D. B.), Extraction and treatment of monazite in North Carolina: *Review of the Chemical Industry*, **20**, 300-306 (1909).
- Proceedings of the second annual drainage convention held at New Bern, North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper **18**, 50 pages (1909).
- Biennial report of the State Geologist for years 1907-1908: *North Carolina Geol. and Ec. Sur.*, 60 pages (1909).
- The mineral production in North Carolina during 1908: *North Carolina Geol. and Ec. Sur.*, Press Bulletin **33**. Also *Jour. Elisha Mitchell Scientific Society*, **25**, 164-167 (1909).
- New type of washer for low-grade gold ores: *Eng. and Min. Jour.*, **87**, 935-938 (1909).
- Drainage of North Carolina swamp lands: *Jour. Am. Peat Soc.*, **2**, 81-85 (1909). Also *Jour. Elisha Mitchell Scientific Society*, **25**, 158-163 (1909).
- The conservation and utilization of our natural resources: *Jour. Elisha Mitchell Scientific Society*, **26**, 1-25 (1910).
- Good roads movement in the South: *Ann. Am. Acad. Pol. and Social Science*, **35**, 105-113 (1910).
- Dirt roads, their construction and maintenance: *Southern Appalachian Good Roads Association, Bulletin* **3**, 3-11 (1910).

- Road engineering problems and the demand for road engineers: *Southern Appalachian Good Roads Association, Bulletin* 8, 3-11 (1910).
- The production of certain of the non-metallic minerals in the South since 1865: *The South and the Building of the Nation*, 6, 233-242 (1910).
- Good roads and conservation: *Jour. Elisha Mitchell Scientific Society*, 26, 135-145 (1910). (And Miss Berry, H. M.), The mining industry in North Carolina during 1908, 1909 and 1910: *North Carolina Geol. and Ec. Sur.*, Economic Paper 23, 134 pages (1911).
- Biennial report of the State Geologist for years 1909-1910: *North Carolina Geol. and Ec. Sur.*, 152 pages (1911).
- Proceedings of the third annual drainage convention: *North Carolina Geol. and Ec. Sur.*, Economic Paper 21, 67 pages (1911).
- Fishing industry in North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper 24, 44 pages (1911).
- Proceedings of the fourth annual drainage convention held at Elizabeth City, North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper 26, 45 pages (1912).
- Report of fisheries convention held at New Bern, North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper 29, 302 pages (1912).
- (And Miss Berry, H. M.), Highway work in North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper 27, 145 pages (1912).
- Proceedings of the annual convention of the North Carolina good roads association: *North Carolina Geol. and Ec. Sur.*, Economic Paper 30, 110 pages (1912).
- Forestry work of the North Carolina Geological and Economic Survey: *North Carolina Geol. and Ec. Sur.*, Economic Paper 25, 22-26 (1912).
- New occurrences of monazite in North Carolina: *Jour. Elisha Mitchell Scientific Society*, 28, 153-156 (1913). Abstract *Geol. Soc. Am., Bull.* 24, 686 (1913).
- Geological history of Western North Carolina: *Jour. Elisha Mitchell Scientific Society*, 29, 35-44 (1913).
- Convict labor in highway construction: *Ann. Am. Acad. Pol. and Social Science*, 46, 78-87 (1913).
- Biennial report of the State Geologist for years 1911-1912: *North Carolina Geol. and Ec. Sur.*, 118 pages (1913).
- Proceedings of the fifth annual drainage convention held at Raleigh, North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper 31, 56 pages (1913).
- Public roads are public necessities: *North Carolina Geol. and Ec. Sur.*, Economic Paper 32, 62 pages (1913).
- Annual address of the President of the National Association of Shellfish Commissioners, Norfolk, Virginia, April 23, 1913: *Jour. Elisha Mitchell Scientific Society*, 29, 50-56 (1913).
- The mining industry in North Carolina during 1911 and 1912: *North Carolina Geol. and Ec. Sur.*, Economic Paper 34, 342 pages (1914). Reprinted in part in *Jour. Elisha Mitchell Scientific Society*, 30, 179-187 (1915).
- The occurrence and utilization of certain mineral resources of the Southern States: *Jour. Elisha Mitchell Scientific Society*, 30, 1-25 and 90-115 (1914).
- (And Miss Berry, H. M.), Good road days: *North Carolina Geol. and Ec. Sur.*, Economic Paper 35, 102 pages (1914).
- (And Miss Berry, H. M.), Proceedings of the North Carolina good roads association, 1913: *North Carolina Geol. and Ec. Sur.*, Economic Paper 36, 127 pages (1914).
- Sandclay and topsoil roads, the economic roads for North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper 39, 35-42 (1914). Also (modified) in *Southern Good Roads*, 9, 5-10 (1914).

- Dirt roads: *North Carolina Geol. and Ec. Sur.*, Economic Paper **39**, 45–48 (1914).
- A forest policy for North Carolina: *North Carolina Geol. and Ec. Sur.*, *Press Bulletin* **130**, 4 pages (1914).
- Mineral production in North Carolina during 1913: *North Carolina Geol. and Ec. Sur.*, *Press Bulletin* **132**, 2 pages (1914).
- The Coggins (Appalachian) gold mine: *Jour. Elisha Mitchell Scientific Society*, **30**, 165–178 (1915).
- Certain magnetic iron ores of Ashe County, North Carolina: *Jour. Elisha Mitchell Scientific Society*, **30**, 179–187 (1915).
- Biennial report of the State Geologist for years 1913–1914: *North Carolina Geol. Sur.*, 176 pages (1915).
- (And Miss Berry, H. M.), Proceedings of the seventh annual drainage convention held at Wilson, North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper **41**, 76 pages (1915).
- Monazite: *Mineral Industry*, **24**, 509–516 (1915).
- The merit system in highway work: *Jour. Elisha Mitchell Scientific Society*, **31**, 86–90 (1915).
- Zircon, monazite and other minerals used in the production of chemical compounds employed in the manufacture of lighting apparatus: *North Carolina Geol. Sur.*, *Bull.* **25**, 120 pages, 3 plates (1916).
- Memorial sketch of Dr. Joseph Austin Holmes: *Jour. Elisha Mitchell Scientific Society*, **32**, 1–15, portrait (1916).
- Memorial of Joseph Austin Holmes: *Geol. Soc. Am. Bull.* **27**, 22–35, portrait (1916).
- (And Miss Berry, H. M.), Proceedings of the second roads institute, 1915: *North Carolina Geol. and Ec. Sur.*, Economic Paper **43**, 128 pages (1916).
- Reclamation of swamp and overflowed lands in North Carolina: *Manufacturer's Record*, **69**, No. 12, 50 (1916).
- Gold mining in the Southern Appalachian Region: *Manufacturer's Record*, **69**, No. 18, 60–61 (1916).
- Monazite: *Mineral Industry*, **24**, 509–516 (1916).
- North Carolina (in part), *New International Encyclopedia*, **17** (1916).
- Monazite in the United States: *Mineral Foot-Notes*, **1**, No. 10, 3–15 (1917).
- Biennial report of the State Geologist for years 1915–1916: *North Carolina Geol. and Ec. Sur.*, 202 pages (1917).
- Altitudes of North Carolina: *North Carolina Geol. and Ec. Sur.*, *Bull.* **27**, 124 pages (1917).
- (And Miss Berry, H. M.), Proceedings of the eighth annual drainage convention: *North Carolina Geol. and Ec. Sur.*, Economic Paper **45**, 90 pages (1917).
- (And Miss Berry, H. M.), Proceedings of the ninth annual drainage convention held at Greensboro, North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper **47**, 110 pages (1917).
- (And Miss Berry, H. M.), Highway work in North Carolina during the calendar year 1914: *North Carolina Geol. and Ec. Sur.*, Economic Paper **44**, 64 pages (1917).
- Mineral production in North Carolina during 1915–1916: *North Carolina Geol. and Ec. Sur.*, *Press Bulletin* **159**, 1–4 (1917).
- The fisheries of North Carolina: *Jour. Elisha Mitchell Scientific Society*, **32**, 149–175 (1917).
- Biennial report of the State Geologist for years 1917–1918: *North Carolina Geol. and Ec. Sur.*, 110 pages (1919).
- (And Miss Berry, H. M.), The mining industry in North Carolina during 1913 to 1917, inclusive: *North Carolina Geol. and Ec. Sur.*, Economic Paper **49**, 170 pages, 1 plate (1919).

- Proceedings of the tenth annual drainage convention held at Washington, North Carolina: *North Carolina Geol. and Ec. Sur.*, Economic Paper **50**, 58 pages (1920).
- Putting lands to their best use; and its relation to our forests and reforestation: *Proc. Third Southern Forestry Congress*, 21–26 (1921).
- Proceedings of the eleventh annual drainage convention: *North Carolina Geol. and Ec. Sur.*, Economic Paper **52**, 69 pages (1921).
- Biennial report of the State Geologist for years 1919–1920, 74 pages (1921).
- The work of the State Geological Survey and mining conditions in North Carolina: *Am. Min. Congress*, Twenty-third Annual Convention, Report of Proceedings, 488–491 (1921).
- Mining in North Carolina: *Eng. and Min. Jour.*, **111**, 181 (1921).
- Extension of Triassic coal field of North Carolina: *Pan-American Geologist*, **37**, 246–248 (1922).
- Recovery of low-grade magnetitic ores in North Carolina: *Pan-American Geologist*, **37**, 345–347 (1922).
- Forestry problem of the Southern Appalachian and southeastern States: *North Carolina Geol. and Ec. Sur.*, circular **3**, 4 pages (1922).
- Forestry problem of the Southern Appalachian and southeastern States: *Proc. Fourth Southern Forestry Congress*, 3–4 (1922).
- Biennial report of the State Geologist and director for years 1921–1922: *North Carolina Geol. and Ec. Sur.*, 104 pages (1923).
- Amendments to the North Carolina drainage law: *North Carolina Geol. and Ec. Sur.*, circular No. **5** (1923).
- North Carolina drainage law: *North Carolina Geol. and Ec. Sur.*, circular No. **8** (1923).
- What the national forests mean to the South: *Proc. Fifth Southern Forestry Congress*, 161–166 (1923).
- Elements of a Federal recreation policy: *The Southern Appalachian Survey*, **51**, 611–612 (1924). Also *Playground*, **18**, 225–226 (1924).
- Abrasive Industry, volume **50** (data concerning Turkish and Grecian emery deposits).
- Diary of Colonel Joseph Hyde Pratt, Commanding 105th Engineers, A.E.F.: *North Carolina Historical Review*, **1**, 35–70; 210–236; 344–380; 475–540 (1924) and **2**, 117–144; 269–279 (1925).
- National forests in the economic life of the South: *Proc. the Eighth Southern Forestry Congress*, 31–34 (1926).
- Diary of Colonel Joseph Hyde Pratt, Commanding 105th Engineers, A.E.F.: Reprinted from the *North Carolina Historical Review* (with additions). 318 pages, map. Edwards and Broughton, Raleigh, N. C. (1926).
- National, state and town forests: *Proc. of the Ninth Southern Forestry Congress*, 33–42 (1927).
- Appalachian power conference and its importance: *Manufacturer's Record*, **92**, No. 1, 73 (1927).
- Fundamental principles of a state forestry organization: *Proc. of the Tenth Southern Forestry Congress*, 4–10 (1928).
- Hiddenite—a rare mineral: *Manufacturer's Record*, **92**, No. 1, 73 (1928).
- Forest research and its importance to the South: *Manufacturer's Record*, **93**, No. 1, 73 (1928).
- Alabama's industrial survey in progress: *Manufacturer's Record*, **94**, No. 14, 68 (1928).
- Trees as an agricultural crop: *Manufacturer's Record*, **94**, No. 18, 71–72 (1928).
- Forestry in the Southern States: *Manufacturer's Record*, **95**, No. 3, 79–80 (1929).

- Lumber and forest products industry of the South: *Ann. Am. Acad. Pol. and Social Science*, 63-75 (1931).
- Gems and gem materials of North Carolina: *Am. Mineral.*, **18**, 148-159 (1933).
- Mineralogical notes on North Carolina minerals: *Jour. Elisha Mitchell Scientific Society*, **49**, 38-39 (1933).
- Aerial photographic mapping by U. S. Geological Survey; development of equipment and methods; preparing the topographic contour map. Illustrated, *Civil Engineering*, **8**, 661-663 (1938).
- History of geological investigations in North Carolina: *Jour. Elisha Mitchell Scientific Society*, **57**, 295-305 (1941).
- American prime meridians: *The Geographical Review*, **32**, 233-244 (1942).

MEMORIAL OF THOMAS LEONARD WALKER

A. L. PARSONS,
University of Toronto, Toronto, Canada.

Thomas Leonard Walker, who died on August 6, 1942, was born near Brampton, Ontario, on December 30, 1867, of English parentage. His father, William Walker was a native of Whitby, England, while his mother, Hannah Sanderson Walker, came from Scarborough, England. He attended schools in both Brampton and Orangeville, Ontario, and then entered Queen's University, Kingston, from which he received the silver medal in chemistry and the degree of Master of Arts in 1890, and at a later period the Gowan Prize in botany.

On his graduation he served on field parties of the Geological Survey of Canada in the Sudbury district where his inability to locate certain contact relations led him to make a detailed study, the results of which appeared in his thesis for the Doctorate under the title "Geological and Petrographical Studies of the Sudbury Nickel District, Canada," and put him in the front rank among petrographers.

For a short time after his graduation from Queen's University he was employed as chemist at the Murray Mine, and for two years was Laboratory Demonstrator in the Faculty of Mines, Queen's University. He was awarded one of the first 1851 Exhibition Scholarships and continued his studies under Professor F. Zirkel in the University of Leipzig where, in 1896, he was awarded the degree of Doctor of Philosophy. At a later time he also continued his studies in crystallography in the University of Heidelberg with Professor Victor Goldschmidt.

In 1897 Dr. Walker was appointed Assistant Superintendent of the Geological Survey of India. While in India he made a scientific expedition across the high passes of the Himalayas into Thibet, making incidentally a collection of Himalayan mosses, many of which were new to science.

In 1901 he returned to Canada to become Professor of Mineralogy and Petrography in the University of Toronto, a position which he held until his retirement in 1937. In 1913, the Royal Ontario Museum of Mineralogy, Toronto, appointed him its first Director. Through the years Dr. Walker worked indefatigably for the Museum. By collecting, judicious purchase and exchange he built up a Museum of Mineralogy which ranks among the best seven in the world.

Dr. Walker was one of the founders of this Society, being one of a small group who conceived the idea at the Baltimore meeting of the Geological Society of America in 1909. With the organization of the Society in December 1919 he became a charter fellow and its first Vice-



THOMAS LEONARD WALKER
1867-1942

President, and two years later he was elected President. While his health remained he was seldom absent from a meeting, usually contributing at least one paper to the program. He prized his association with the Society for the stimulus which he gained from the meetings and the friends that he made and kept among the members.

He was a fellow of the Geological Society of America (1903) and, as President of our Society, was its 3rd Vice-President in 1922 and was elected as 1st Vice-president in 1931.

He was made an honorary member of the Mineralogical Society of Great Britain and Ireland in 1937 after being an ordinary member since 1913.

He was a Fellow of the Royal Society of Canada and President of Section IV (Geological Sciences) 1927-28; a Fellow of the Geological Society of London; Fellow of the Royal Geological Society of Cornwall; member of the Washington Academy of Sciences; and member of the Canadian Institute of Mining and Metallurgy.

For many years he was a member of the Committee on the Measurement of Geologic Time in the National Research Council (United States).

He was an indefatigable worker, as shown by the bibliography which appears later, and accomplished much that was worth while. His thesis for the doctorate started an intensive study of the conditions governing the deposition of the nickel-copper ores of the Sudbury basin. His reports on the tungsten ores of Canada and on the molybdenum ores of Canada called attention to materials that have become of great importance. He was one of the pioneers in the use of the two-circle goniometer on this continent and wrote his Crystallography to make this method more readily available in the English language.

The mineral temiskamite, almost simultaneously described under the name maucherite, which was described by him was the cause of much dispute as to its true composition. The latest examination by means of x -rays agrees within reasonable limits with the composition as given by Walker, although the name maucherite is preserved as having priority in publication. Other minerals which were described by him are spencerite, chapmanite, schoepite, enelectrite, and in collaboration with the writer, ellsworthite.

In view of the limited facilities for publishing in English articles dealing with mineralogy and petrography, he started the series of "Contributions to Canadian Mineralogy from the Department of Mineralogy and Petrography in the University of Toronto" in 1921. This publication has appeared annually since that time, except for the year 1936, when he was stricken with his fatal illness. It was then deferred until the next year when a double number was issued.

Special recognition was given to the accomplishments of Dr. Walker in 1938 when the University of Toronto granted him the degree of Doctor of Science (*honoris causa*), and in 1941 the Royal Society of Canada conferred further honour by the bestowal of the Flavelle Medal for his important contributions to mineralogical science.

He travelled widely and was a member of nearly every International Geological Congress during his academic career, and on each occasion he brought home material to enrich the collections of the University and of the Royal Ontario Museum of Mineralogy. His greatest personal pleasure however, was probably in the meetings of this Society for the stimulus that he derived, and from the meetings of the Canadian Institute of Mining and Metallurgy where he was able to keep in intimate touch with the mineral industry of Canada.

Dr. Walker will be remembered because of the men he trained. He will also be long remembered as the builder of a great mineral museum. To these great objectives he devoted his life and his accomplishments were of no mean order.

In 1906 Dr. Walker married Mary Augusta Woods, daughter of the late Sir James Woods of Toronto, who survives him. He is also survived by two sons, James Woods Walker and William P. Walker, and one daughter, Euphemia B. Walker.

BIBLIOGRAPHY

- Notes from the chemical laboratory, Queen's University: *Can. Rec. Sci.* (1893).
 Notes on nickeliforous pyrite from Murray Mine, Sudbury, Ontario: *Am. Jour. Sci.*, **47** (1894).
 Diabase dykes in the Sudbury mining region: *Jour. Ont. Min. Inst.* (1895).
 Observations on percussion figures on cleavage plates of mica: *Am. Jour. Sci.*, **2** (1896).
 Beitrag zur Kenntniss des Sperryoliths: *Zeits. Kryst.*, **25** (1896).
 Notes on sperrylite: *Am. Jour. Sci.*, **1** (1896).
 Geological and petrographical studies of the Sudbury nickel district, Canada: *Q.J.G.S.*, **53** (1897).
 Percussion figures on micas: *Rec. Geol. Surv. India*, **30** (1898).
 Examination of some triclinic minerals by means of etching figures: *Am. Jour. Sci.*, **5** (1898).
 Causes of variation in the composition of igneous rocks: *Am. Jour. Sci.*, **6** (1898).
 The crystalline symmetry of torbernite: *Am. Jour. Sci.*, **6** (1898).
 The crystal symmetry of the minerals of the mica group: *Am. Jour. Sci.*, **7** (1899).
 A geological sketch of the central portion of Jeypore Zamindari, Vizagapatam District: *Gen. Rep. Geol. Surv. India* (1900).
 The geology of Kalahandi State, Central Provinces: *Mem. Geol. Surv. India*, **33** (1902).
 The Geological Survey of Canada as an educational institution: *Jour. Can. Min. Inst.*, **7** (1904).
 (With Collins, W. H.), Petrological study of some rocks from Hill Tracts, Vizagapatam District, Madras Presidency: *Rec. Geol. Surv. India*, **36** (1907).

- Nepheline syenites from the Hill Tracts of Vizagapatam Dist., Madras Presidency: *Rec. Geol. Surv. India*, **36** (1908).
- A review of the minerals tungstite and meymacite: *Am. Jour. Sci.*, **25** (1908).
- The occurrence of tungsten ores in Canada: *Trans. Can. Min. Inst.*, **11** (1908).
- Report on the tungsten ores in Canada: *Mines Branch*, **25** (1909).
- Recently discovered wolframite deposits in New Brunswick: *Ec. Geol.*, **6** (1911).
- Report on the molybdenum ores of Canada: *Mines Branch*, **93** (1911).
- Minerais de molybdene du Canada: *Mines Branch* (1912).
- The gold fields of New Ontario (Translation from Baelz): *Can. Min. Jour.* (1912).
- Rapport sur les mineraux de tungstene du Canada: *Mines Branch*, **156** (1913).
- Crystallography (1914).
- Temiskamite, a new nickel arsenide from Ontario: *Am. Jour. Sci.*, **37** (1914).
- Minerals from Baffin Land: *Ottawa Naturalist* (1915).
- On the separation and determination of nickel and cobalt: *Trans. Roy. Soc.*, **9** (1915).
- Certain mineral occurrences in the Worthington Mine, Sudbury, Ontario, and their significance: *Ec. Geol.*, **10** (1915).
- Hopeite from the H. B. Mine, Salmo, B. C.: *Jour. Wash. Acad. Sci.*, **6** (1916).
- Spencerite, a new zinc phosphate from British Columbia: *Mineral. Mag.*, **18** (1916).
- The crystal form of spencerite: *Jour. Wash. Acad. Sci.*, **7** (1917).
- (With Ledoux, A., and Wheatley, A. C.), The crystallization of parahopeite: *Mineral. Mag.*, **18** (1917).
- Mineralogy of the H. B. Mine, Salmo, B. C.: *Univ. Tor. Studies, Geol. Ser.* **10** (1918).
- (With Ledoux, A.), Cerussite from Salmo, B. C.: *Ottawa Naturalist*, **32**, (1918).
- Stalactitic barite and fluorite from Madoc, Ontario: *Am. Mineral.*, **4** (1919).
- (With Parsons, A. L., and Thomson, E.), Notes on Mineralogy: *Univ. of Toronto* (1920).
- Skutterudite from Cobalt, Ontario: *Am. Mineral.*, **6** (1921).
- "Allemontite" from Atlin, B. C.: *Am. Mineral.*, **6** (1921).
- Cleavable bornite from Usk, B. C.: *Am. Mineral.*, **6** (1921).
- Cosalite from Ontario: *Univ. Tor. Studies, Geol. Ser.* **12** (1921).
- Dyscrasite from Cobalt, Ontario: *Univ. Tor. Studies, Geol. Ser.* **12** (1921).
- Epsomite lakes near Ashcroft, B. C.: *Univ. Tor. Studies, Geol. Ser.* **12** (1921).
- Orthoclase from Penticton, B. C.: *Univ. Tor. Studies, Geol. Ser.* **12** (1921).
- Ulexite from the Maritime Provinces: *Univ. Tor. Studies, Geol. Ser.* **12** (1921).
- A chemical study of conglomerates: *Univ. Tor. Studies, Geol. Ser.* **12** (1921).
- (With Parsons, A. L.), Rammelsbergite from Cobalt, Ontario: *Univ. Tor. Studies, Geol. Ser.* **12** (1921).
- (With Parsons, A. L.), The dehydration of spencerite: *Univ. Tor. Studies, Geol. Ser.* **12** (1921).
- Alteration of silicates by Sonstadt's Solution: *Am. Mineral.*, **7** (1922).
- Dumortierite from Ashby Township, Addington County, Ontario: *Univ. Tor. Studies, Geol. Ser.* **14** (1922).
- Copiapite from Liard Post, B. C.: *Univ. Tor. Studies, Geol. Ser.* **14** (1922).
- Fibroferrite from Quatsino, B. C.: *Univ. Tor. Studies, Geol. Ser.* **14** (1922).
- (With Parsons, A. L.), Tubular amygdaloid from Nova Scotia: *Univ. Tor. Studies, Geol. Ser.* **14** (1922).
- (With Parsons, A. L.), The zeolites of Nova Scotia: *Univ. Tor. Studies, Geol. Ser.* **14** (1922).
- (With Parsons, A. L.), Notes on some Canadian diopsides: *Univ. Tor. Studies, Geol. Ser.* **14** (1922).
- The development of mineralogical methods: *Am. Mineral.*, **8** (1923).
- Schoepite, a new uranium mineral from Kasalo, Belgian Congo: *Am. Mineral.*, **8** (1923).

- Trevorite, a distinct mineral species: *Univ. Tor. Studies, Geol. Ser. 16* (1923).
- Huronite from Gowganda, Ontario: *Univ. Tor. Studies, Geol. Ser. 16* (1923).
- (With Parsons, A. L.), The North Mountain basalt of Nova Scotia—glaciation, tubular amygdaloid, mordenite, and louisite: *Univ. Tor. Studies, Geol. Ser. 16* (1923).
- (With Parsons, A. L.), Ellsworthite and associated minerals from Hybla, Ontario: *Univ. Tor. Studies, Geol. Ser. 16* (1923).
- (With Parsons, A. L.), Hatchettolite and associated minerals from Hybla, Ontario: *Univ. Tor. Studies, Geol. Ser. 16* (1923).
- (With Parsons, A. L.), Shattering of minerals and rocks about inclusions: *Univ. of Tor. Studies, Geol. Ser. 16* (1923).
- (With Parsons, A. L.), Notes on Canadian minerals—allanite, axinite, columbite, and sillimanite: *Univ. Tor. Studies, Geol. Ser. 16* (1923).
- Hafnium or jargonium: *Nature* (1923).
- Chemical and microscopic examination of ferric and ferrous vein materials and chert from the Keeley Mine: *Univ. Tor. Studies, Geol. Ser. 17* (1924).
- Chapmanite, a new hydrous ferrous silico-antimonate from South Lorrain, Ontario: *Univ. Tor. Studies, Geol. Ser. 17* (1924).
- Uraninite from Cardiff Township, Ontario: *Univ. Tor. Studies, Geol. Ser. 17* (1924).
- The age of some Canadian pegmatites: *Univ. Tor. Studies, Geol. Ser. 17* (1924).
- Hastingsite from Dungannon Township, Hastings County, Ontario: *Univ. Tor. Studies, Geol. Ser. 17* (1924).
- (With Parsons, A. L.), Skutterudite and loellingite from the La Rose Mine, Cobalt, Ontario: *Univ. Tor. Studies, Geol. Ser. 17* (1924).
- (With Parsons, A. L.), The arsenates of cobalt, nickel and iron observed in the silver-bearing veins at Cobalt, Ontario: *Univ. Tor. Studies, Geol. Ser. 17* (1924).
- (With Parsons, A. L.), Pegmatite minerals from New Ross, Nova Scotia: *Univ. Tor. Studies, Geol. Ser. 17* (1924).
- Arsenides from the silver veins of South Lorrain, Ontario: *Univ. Tor. Studies, Geol. Ser. 20* (1925).
- (With Parsons, A. L.), Evanescent pink sodalite and associated minerals from Dungannon Township, Ontario: *Univ. Tor. Studies, Geol. Ser. 20* (1925).
- (With Parsons, A. L.), The characteristics of primary calcite: *Univ. Tor. Studies, Geol. Ser. 20* (1925).
- (With Parsons, A. L.), Axinite from the Moneta Mine, Timmins, Ontario: *Univ. Tor. Studies, Geol. Ser. 20* (1925).
- (With Parsons, A. L.), Petzite from the Hollinger Gold Mine: *Univ. Tor. Studies, Geol. Ser. 20* (1925).
- (With Parsons, A. L.), The rate of oxidation of arsenides of iron, cobalt and nickel: *Univ. Tor. Studies, Geol. Ser. 20* (1925).
- (With Parsons, A. L.), A comparison of the Port Arthur, Cobalt, South Lorrain and Gowganda silver-vein minerals: *Univ. Tor. Studies, Geol. Ser. 20* (1925).
- (With Parsons, A. L.), New localities for Canadian minerals: *Univ. Tor. Studies, Geol. Ser. 20* (1925).
- (With Parsons, A. L.), Minerals from the new nepheline syenite area, French River, Ontario: *Univ. Tor. Studies, Geol. Ser. 22* (1926).
- (With Parsons, A. L.), Zeolites and related minerals from Lake Nipigon, Ontario: *Univ. Tor. Studies, Geol. Ser. 22* (1926).
- (With Parsons, A. L.), Apatite, lepidomelane and associated minerals from Faraday Township, Hastings County, Ontario: *Univ. Tor. Studies, Geol. Ser. 22* (1926).

- (With Parsons, A. L.), Changes in water level and flotation as forces of erosion: *Univ. Tor. Studies, Geol. Ser.* **22** (1926).
- (With Parsons, A. L.), A re-examination of bytownite and huronite: *Univ. Tor. Studies, Geol. Ser.* **24** (1927).
- (With Parsons, A. L.), Beryl and associated minerals from Lyndoch Township, Renfree County, Ontario: *Univ. Tor. Studies, Geol. Ser.* **24** (1927).
- (With Parsons, A. L.), Notes on Canadian minerals—tremolite, clinohumite, stromeyerite, natron, and hexahydrite: *Univ. Tor. Studies, Geol. Ser.* **24** (1927).
- (With Parsons, A. L.), The contact phenomena of the nepheline syenites of Port Coldwell, Ontario: *Univ. Tor. Studies, Geol. Ser.* **24** (1927).
- (With Gerrie, Wm.), Influence of hot natural brines on dolomitization: *Univ. Tor. Studies, Geol. Ser.* **24** (1927).
- (With Coleman, A. P., and Moore, E. S.), The Sudbury nickel intrusive: *Univ. Tor. Studies, Geol. Ser.* **28** (1929). Abstract: *Compte Rendu, XV Internat. Geol. Cong.* (1929).
- Mineral association at the Marble Bay Mine, Texada Island, B. C.: *Univ. Tor. Studies, Geol. Ser.* **29** (1930).
- Dalmatianite, the spotted greenstone from the Amulet Mine, Noranda: *Univ. Tor. Studies, Geol. Ser.* **29** (1930).
- Stephanite, argentite and silver, South Lorrain, Ontario: *Univ. Tor. Studies, Geol. Ser.* **29** (1930).
- Lodestone from Bon Accord, Transvaal: *Univ. Tor. Studies, Geol. Ser.* **29** (1930).
- (With Parsons, A. L.), Notes on minerals—calamine, galena, magnetite: *Univ. Tor. Studies, Geol. Ser.* **29** (1930).
- (With Thomson, E.), An examination of lillianite and galenobismutite: *Univ. Tor. Studies, Geol. Ser.* **29** (1930).
- Alexoite, a pyrrhotite-peridotite from Ontario: *Univ. Tor. Studies, Geol. Ser.* **30** (1931).
- Rare minerals in pegmatite, Pointe du Bois, Manitoba: *Univ. Tor. Studies, Geol. Ser.* **30** (1931).
- Polarity in magnetite: *Univ. Tor. Studies, Geol. Ser.* **30** (1931).
- Mineralogy in Canada, 1882–1932 (1932).
- Thomsonite from Sextant Rapids, Timiskaming Dist., Ont.: *Univ. Tor. Studies, Geol. Ser.* **32** (1932).
- Plagioclase in graphic granite: *Univ. Tor. Studies, Geol. Ser.* **32** (1932).
- Ribbed concretions from the Animikie slates at Port Arthur, Ontario: *Univ. Tor. Studies, Geol. Ser.* **32** (1932).
- Notes on tungstite: *Univ. Tor. Studies, Geol. Ser.* **35** (1933).
- Chemawinitite or Canadian amber: *Univ. Tor. Studies, Geol. Ser.* **36** (1934).
- Eneclitrite, a new mineral found in chemawinitite: *Univ. Tor. Studies, Geol. Ser.* **36** (1934).
- A study of the mineral composition of mine dust: *Univ. Tor. Studies, Geol. Ser.* **38** (1935).
- Magmatic differentiation as shown in the nickel-intrusive of Sudbury, Ontario: *Univ. Tor. Studies, Geol. Ser.* **38** (1935).
- An unusual type of quartz: *Univ. Tor. Studies, Geol. Ser.* **38** (1935).
- (With Parsons, A. L.), The Royal Ontario Museum of Mineralogy: *Museums Journal*, **35** (1936).

MINERALOGICAL SOCIETY OF AMERICA PROCEEDINGS FOR 1942

PAUL F. KERR, *Secretary.*

It has been customary at this time, for a period of twenty-two years, to present the proceedings of the annual meeting of the Mineralogical Society of America. Since the initial annual meeting in Chicago in 1920 this is the first year in which the mineralogists of the United States and Canada have not held an official gathering. In the absence of a report on the annual meeting, the officers of the society submit at this time the various items of information which it is felt should be placed on record for the benefit of the society. These are:

ABSTRACTS OF PAPERS PRESENTED BY TITLE.

REPORT ON THE ELECTION OF OFFICERS AND FELLOWS FOR 1943.

REPORTS OF THE SECRETARY, EDITOR, TREASURER, AND AUDITING COMMITTEE.

MEMORIALS TO ARTHUR P. HONESS, JOSEPH HYDE PRATT, AND THOMAS L. WALKER.

LIST OF FORMER OFFICERS AND MEETING PLACES OF THE SOCIETY.

CORRESPONDENTS, FELLOWS, MEMBERS, AND SUBSCRIBERS OF THE MINERALOGICAL SOCIETY OF AMERICA.

ABSTRACTS OF PAPERS PRESENTED BY TITLE

MASSIVE BIXBYITE (Mn, Fe), O_2 OF LOW IRON CONTENT

JOHN W. GRUNER, *University of Minnesota, Minneapolis, Minnesota.*

About 10 years ago the writer obtained two hand specimens from Ward's Natural Science Establishment labelled "Braunite, Postmasburg District, Cape Province, South Africa." The specimens are dense, massive, and look metallic like magnetite. The streak is dark brown. X-rays show that the mineral is bixbyite. The small amount of other material associated with the mineral is dull black and contains small stringers of bixbyite. There are also flakes of a shiny, dark gray mineral present which look like molybdenite. Hand picked flakes were x-rayed and the pattern corresponds to a new manganese mineral called oakite by W. E. Richmond. Oakite is found at White Oak Mountain, Tenn.

The bixbyite contains 17.25% Fe_2O_3 and 0.9% SiO_2 . This means that it is the lowest in Fe_2O_3 ever found. It contains less than half as much Fe_2O_3 as any of the other three occurrences reported. It is the only massive variety recorded. Bixbyite is cubic. The edge of its unit cell as measured by Pauling is 9.35 Å. This material measures 9.39 Å, while artificial Mn_2O_3 as measured by the writer gave 9.42 Å. Such an increase in the size would be expected as Fe_2O_3 decreases. The writer has tried to obtain more of this mineral from Postmasburg but so far without success. A large number of specimens must be in various collections under the name "braunite."

IRIDESCENT GARNET FROM THE ADELAIDE MINING DISTRICT, NEVADA

EARL INGERSON AND JULIAN D. BARKSDALE,

Geophysical Laboratory, Washington, D. C.

Garnets from a lime-rich layer in the contact zone of a granodiorite stock show brilliant iridescence, both on striated faces and in thin section. They are birefringent and show, superposed on the triangular segments that are common in lime contact garnets, lamellae

that look like polysynthetic twinning. Universal stage measurements show that the lamellae are parallel to $\{110\}$ and $\{111\}$. It appears that the iridescence is due to the very fine $\{111\}$ lamellae and that it is more intense where the individual lamellae are finer.

ON THE CRYSTALLOGRAPHY OF PYROSTILPnite

M. A. PEACOCK, *University of Toronto, Toronto, Canada.*

Crystals of pyrostitilpnite (fireblende) from Andreasberg, Harz, are monoclinic, elongated with $\{001\}$, flattened on $\{010\}$, and striated parallel to $[100]$. The observed forms are $\{010\}$, $\{110\}$, $\{021\}$, $\{031\}$ new, $\{041\}$, with reference to:

$$a:b:c=0.4318:1:0.3941; \beta=117^{\circ}09'$$

given by the unit cell dimensions. The (010) -centred lattice has $a'=12.15$, $b'=15.81$, $c'=6.23$ Å, $\beta=90^{\circ}$, space-group $B2_1/c-C_{2h}^6$, giving the unit cell with $a=6.83$, $b=15.81$, $c=6.23$ Å, $\beta=117^{\circ}09'$, space-group $P2_1/c-C_{2h}^6$. The unit cell contains $\text{Ag}_{12}\text{Sb}_4\text{S}_{12}=2[3\text{Ag}_2\text{S}\cdot\text{Sb}_2\text{S}_3]$; calculated density 5.97, measured 5.94 (Berman, priv. com.). The monoclinic prismatic class $(2/m)$ is directly established by the x -ray effects. The optical behavior, which has suggested triclinic symmetry, is due to twinning on the vertical axis with composition on a vertical plane, usually $\{010\}$ (Carlsbad law).

On minute crystals of pyrostitilpnite from Randsburg, California (*Am. Mineral.*, **26**, 130, 1941), Murdoch (priv. com.) has noted the forms $\{010\}$, $\{130\}$ new, $\{110\}$, $\{011\}$, $\{021\}$, $\{031\}$, $\{041\}$, $\{051\}$, in P -notation, and has obtained the cell dimensions $a'=12.2$, $b'=15.87$, $c'=6.28$ Å, $\beta=90^{\circ}\pm 30'$, in close agreement with the values for Andreasberg.

TRIDYMITe LATITE FROM SODA CREEK, BRITISH COLUMBIA

LOUISE STEVENS STEVENSON, *Victoria, B. C.*

The Cariboo district of west central British Columbia has long been known to contain numerous Tertiary basalt flows and great thicknesses of ash beds, but the Soda Creek latite is unique in being the first siliceous lava to be described from this area. It occurs as a plug-like outcrop of grayish-white vesicular rock. A detailed petrographic description is given, including optical constants of the principal minerals and results of Rosiwal determinations.

ELECTION OF OFFICERS AND FELLOWS FOR 1943

The secretary announces that 325 ballots have been cast for the officers of the society as nominated by the Council. Officers for 1943 are:

President: J. F. Schairer, Geophysical Laboratory, Washington, D. C.

Vice-President: John W. Gruner, University of Minnesota, Minneapolis, Minnesota.

Secretary: Paul F. Kerr, Columbia University, New York, N. Y.

Treasurer: Earl Ingerson, Geophysical Laboratory, Washington, D. C.

Editor: Walter F. Hunt, University of Michigan, Ann Arbor, Michigan.

Councilor, 1943-1946: C. S. Hurlbut, Jr., Harvard University, Cambridge, Massachusetts.

The secretary announces that according to the provisions of the constitution the following have been elected to fellowship:

Bandy, Mark C., Patino Mines and Enterprises, Llallagua, Bolivia.

Berry, Leonard G., Research Enterprises, Ltd., Leaside, Ontario, Canada.

Bannerman, Harold M., Dartmouth College, Hanover, New Hampshire.
 Fahey, Joseph J., U. S. Geological Survey, Washington, D. C.
 Ford, Hugh A., British Consul General, Boston, Massachusetts.
 Lee, Harley C., Basic Magnesium, Inc., Las Vegas, Nevada.
 Lopez, Victor M., Servicio Tecnico de Minería y Geología, Caracas, Venezuela.
 Merritt, Clifford A., University of Oklahoma, Norman, Oklahoma.
 Merritt, Phillip L., American Cyanamid Company, Stamford, Connecticut.
 Mertie, John B., Jr., U. S. Geological Survey, Washington, D. C.
 Richmond, Wallace E., U. S. Geological Survey, Washington, D. C.
 Stevens, Rollin E., U. S. Geological Survey, Washington, D. C.
 Stevenson, John S., Department of Mines, Victoria, British Columbia, Canada.
 Wolfe, C. W., Boston University, Boston, Massachusetts.

REPORT OF THE SECRETARY, 1942

MEMBERSHIP STATISTICS

	1941	1942	Gain	Loss	Removals due to war causes
Correspondents	6	6	0	0	0
Fellows	193	199	14	8	5
Members	426	418	85	93	47
Subscribers	314	268	30	76	132
	939	891	129	177	184

During 1942, the net loss in total membership has been 48, a figure very close to the net loss of 50 in 1941, and once again a 5% decrease on the basis of the previous year's total membership. In 1941, a major part of the decrease resulted from the removal of practically all members and subscribers in Germany; in 1942, suspension of mail service to Japan and the U.S.S.R. accounted for the greater part of the decrease. In spite of the removal of many foreign members outside of the western hemisphere, enough new members have been obtained from the United States, Canada, and South America to counterbalance the effect from the standpoint of membership alone.

It is known that at least 3 fellows and 22 members are serving in the armed forces in various capacities. In addition, more than 70 fellows and members are serving with government agencies in the prosecution of work on strategic minerals.

It is impossible to indicate definitely the number of members and subscribers removed solely because of the war. In many cases, no word has come through at all; in others, word has been received to the effect that money cannot be sent out of the country until the present conflict is over; in others, temporary arrangements have been made for subscriptions. In a column under the membership statistics, an attempt has been made to indicate the approximate loss of fellows, members and subscribers from this cause.

Respectfully submitted,

PAUL F. KERR, *Secretary*

REPORT OF THE EDITOR FOR 1942

To the Council, Fellows and Members of the Mineralogical Society of America:

When one considers the many disturbing factors that have altered all normal procedure for the past twelve months, it is gratifying to report that in spite of these ever-changing

conditions which have affected every business and profession, we have, thus far, carried on our assigned task in a satisfactory manner. It is perfectly true that some delay has been experienced at times in releasing issues, due to the fact that we must now secure the approval of the Board of Economic Warfare for every issue of the Journal before final printing and distribution are permitted. While this permission is needed for export only, we still have at present about 110 names on our mailing list to which this edict directly applies. No license permit is required to export copies to Canada or to the insular possessions of the United States. The examination of the proof material is for the purpose of determining whether or not the issue should be exported. Thus far no issue of *The American Mineralogist* has been refused this privilege, but an additional ten days to two weeks are required to clear this hurdle and this ruling is largely responsible for the delay our readers have experienced in recent months in receiving their issues.

Printing costs of our Journal have advanced somewhat during the past year but thus far the increase has been slight and affects the item of labor, but not materials used. With increased printing costs and reduced revenues from dues and subscriptions, the Society would have been forced to retrench by reducing the size of the Journal except for the generous action taken by the Council of the Geological Society of America. That body very graciously voted to increase their contribution for 1942 from \$1500 to \$2000. This additional \$500 is reflected in the 90 page increase in size of volume 27 over that of the previous year.

During 1942 the number of manuscripts received has been unusually large and this in spite of the fact that many students of geology and mineralogy were transferring from scientific and academic pursuits to work directly connected with the war effort. Perhaps the large number of papers received represents a final effort on the part of many to complete manuscripts on hand before entering upon their new duties. Just to what extent this dislocation of normal research in mineralogical and geological fields will affect papers submitted to our Journal during 1943 and subsequent years cannot at present be foretold. At the present writing sufficient manuscripts are on hand to carry us through the spring and early summer issues.

Summarizing the factual data for the year, we find that volume 27 contains 826 pages, exclusive of index. This represents a 90 page increase (12.2%) over the preceding year. Approximately 84.4% of the total space of the Journal is devoted to leading articles which number 55. A few of these major contributions are rather long so that the average length per article has risen to 12.7 printed pages. Table 1 which accompanies this report indicates the distribution of the leading articles in the nine fields covered by the Journal. Over one-half of the papers (64%) printed this year fall in the three divisions of descriptive and chemical mineralogy and petrography. If to the main articles we add 18 shorter papers, appearing under the heading of Notes and News, we obtain a total of 73 published manuscripts for the calendar year. These contributions were received from 89 contributors associated with 45 different universities, research bureaus and technical laboratories. *The American Mineralogist* for 1942 carries detailed descriptions of two new minerals: sampleite and cryptomelane. 195 illustrations of various types make it possible to follow more intelligently the descriptive portions of the text. As in previous years this liberal use of cuts has been made possible in numerous instances by financial aid received from authors or institutions when the cost of cuts for any single article would have placed too heavy a burden upon the Society.

The accompanying table of contents summarizes in detail the distribution of subject matter in Volume 27.

TABLE 1. DISTRIBUTION OF SUBJECT MATTER IN VOLUME 27

<i>Subjects</i>	<i>Articles</i>	<i>Pages</i>	<i>Per Cent of Total</i>
Leading articles*			
Descriptive mineralogy	12		
Chemical mineralogy	11		
Structural crystallography	7		
Geometrical crystallography	3		
Petrography	12		
Optical mineralogy	2		
Mineralography	1		
Memorials	4		
Miscellaneous	3		
	55	697	84.4
Short articles	18	48½	15.6
Proceedings of societies	21	59	
Notes and news	15	5	
Abstracts of new mineral names	19	10	
Book reviews	8	6½	
Total entries	136	826	100.0
Illustrations	195		
Index, title page, table of contents		15	
Grand total		841	

* (Average length of leading articles, 12.7 printed pages)

Respectfully submitted

WALTER F. HUNT, *Editor*

REPORT OF THE TREASURER FOR 1942

To the Council of the Mineralogical Society of America:

Your treasurer submits herewith his annual report for the year beginning December 1, 1941 and ending November 30, 1942.

Receipts

Cash on hand December 1, 1941.....	\$ 1,899.46
Dues and subscriptions.....	2,803.62
Sale of back numbers.....	437.37
Authors' charges on separates.....	697.59
Sale of 20-volume index.....	26.00
Interest and dividends from endowment.....	2,544.50
Partial payments (1942) on principal of Trenton Mortgage Service Company's preferred stock.....	187.57
Geological Society of America Grant for 1942.....	2,000.00
Advertisements.....	311.18
Aid in publishing long papers.....	298.92
Postage refund for numbers returned.....	1.92
	\$11,208.13

DISBURSEMENTS

Printing and distribution of the Journal (12 issues).....	\$ 5,591.73
Printing and distribution of separates.....	758.56
To the Editor, Secretary, and Treasurer.....	970.00
Postage.....	104.15
Printing and stationery.....	177.58
Office equipment.....	20.76
Clerical help.....	384.25
Committee expenses.....	3.00
Safety deposit box.....	9.60
Roebing Medal, 1941.....	110.32
Telegrams.....	1.36
Refunds on dues and subscriptions.....	3.21
Notary fees; applications for license to export Journal.....	1.50
Investment of accumulated endowment funds.....	1,107.50
Service charge on purchase of stock.....	2.34
Returned checks.....	9.00
	\$ 9,254.86
Cash balance November 30, 1942.....	1,953.27
	\$11,208.13

The endowment funds of the Society as of November 30, 1942, consist of the following securities:

45 \$1,000 bonds, City and County of Honolulu, Territory of Hawaii, Water Works, 5%, due April 15, 1954.....	\$45,000.00
4 \$100 bonds, Great Northern Railway Company, Genl. Mtg., 5½%, due January 1, 1952.....	400.00
37-514/1000 shares, Trenton Mortgage Service Company, Trenton, N. J., preferred stock.....	2,584.76
15 shares, American Telephone and Telegraph Company, common stock.....	1,728.07*
5 shares, Public Service of New Jersey, 8% preferred stock.....	702.00*
5 shares, United States Steel, 7% preferred stock.....	502.45*
10 shares, Consolidated Edison, 5% preferred stock.....	1,066.64*
20 shares, Union Pacific Railroad Co., 4% preferred stock.....	1,607.75*
* Purchase price.....	\$53,591.67

Respectfully submitted,
EARL INGERSON, *Treasurer*

REPORT OF THE AUDITING COMMITTEE

To the President of the Mineralogical Society of America:

The Auditing Committee has examined and verified the accounts of the Treasurer of the Mineralogical Society of America, for the fiscal year ending November 30, 1942. The securities listed in the Treasurer's report, with all future coupons on the coupon bonds attached, are in the safety deposit box at the Friendship Branch of the Riggs National Bank of Washington, D. C.

Respectfully submitted,
MICHAEL FLEISCHER, *Chairman*
JOHN P. MARBLE
R. E. STEVENS

DANA FUND

No disbursement made during the fiscal year 1942. Interested received = \$17.95. Available balance, November 30, 1942, = \$913.43.

Respectfully submitted,
WALDEMAR T. SCHALLER

LIST OF FORMER OFFICERS AND MEETING PLACES

By recommendation of the Council, a complete list of past officers is printed in the proceedings of the annual meeting of the Society:

PRESIDENTS

1920 Edward H. Kraus
1921 Charles Palache
1922 Thomas L. Walker
1923 Edgar T. Wherry
1924 Henry S. Washington
1925 Arthur S. Eakle
1926 Waldemar T. Schaller
1927 Austin F. Rogers
1928 Esper S. Larsen
1929 Arthur L. Parsons
1930 Herbert E. Merwin
1931 Alexander H. Phillips
1932 Alexander N. Winchell
1933 Herbert P. Whitlock
1934 John E. Wolff
1935 Clarence S. Ross
1936 William S. Bayley
1937 Norman L. Bowen
1938 Ellis Thomson
1939 Max N. Short
1940 William F. Foshag
1941 Frederick E. Wright
1942 Arthur F. Buddington

VICE-PRESIDENTS

Thomas L. Walker
Waldemar T. Schaller
Frederick A. Canfield
George F. Kunz
Washington A. Roebing
Herbert P. Whitlock
George Vaux, Jr.
George L. English
Lazard Cahn
Edward Wigglesworth
John E. Wolff
William F. Foshag
Joseph L. Gillson
Frank N. Guild
William A. Tarr
Ellis Thomson
Harold L. Alling
H. V. Ellsworth
Kenneth K. Landes
Burnham S. Colburn
Ian Campbell
William J. McCaughey
Martin J. Buerger

SECRETARIES

1920-1922 Herbert P. Whitlock
1923-1933 Frank R. Van Horn
1933-1934 Albert B. Peck
1934- Paul F. Kerr

TREASURERS

1920-1923 Albert B. Peck
1924-1929 Alexander H. Phillips
1929-1930 Albert B. Peck
1931-1940 Waldemar T. Schaller
1941- Earl Ingerson

EDITORS

1920-1921 Edgar T. Wherry
1922- Walter F. Hunt

COUNCILORS

- 1920 Arthur S. Eakle, Frank R. Van Horn, Fred. E. Wright, Alexander H. Phillips.
- 1921 Frank R. Van Horn, Fred. E. Wright, Alexander H. Phillips, Austin F. Rogers.
- 1922 Fred. E. Wright, Alexander H. Phillips, Austin F. Rogers, Thomas L. Watson.
- 1923 Alexander H. Phillips, Austin F. Rogers, Thomas L. Watson, Esper S. Larsen.
- 1924 Austin F. Rogers, Thomas L. Watson, Esper S. Larsen, Arthur L. Parsons.
- 1925 Thomas L. Watson, Esper S. Larsen, Arthur L. Parsons, William F. Foshag.
- 1926 Esper S. Larsen, Arthur L. Parsons, William F. Foshag, William A. Tarr.
- 1927 Arthur L. Parsons, William F. Foshag, William A. Tarr, Alexander N. Winchell.
- 1928 William F. Foshag, William A. Tarr, Alexander N. Winchell, Ellis Thomson.
- 1929 William A. Tarr, Alexander N. Winchell, Ellis Thomson, Clarence S. Ross.
- 1930 Alexander N. Winchell, Ellis Thomson, Clarence S. Ross, Paul F. Kerr.
- 1931 Ellis Thomson, Clarence S. Ross, Paul F. Kerr, William S. Bayley.
- 1932 Clarence S. Ross, Paul F. Kerr, William S. Bayley, William J. McCaughey.
- 1933 Paul F. Kerr, William S. Bayley, William J. McCaughey, Kenneth K. Landes.
- 1934 William S. Bayley, William J. McCaughey, Kenneth K. Landes, E. P. Henderson.
- 1935 William J. McCaughey, Kenneth K. Landes, E. P. Henderson, J. F. Schairer.
- 1936 Kenneth K. Landes, E. P. Henderson, J. F. Schairer, Arthur F. Buddington.
- 1937 E. P. Henderson, J. F. Schairer, Arthur F. Buddington, Arthur P. Honess.
- 1938 J. F. Schairer, Arthur F. Buddington, Arthur P. Honess, R. C. Emmons.
- 1939 Arthur F. Buddington, Arthur P. Honess, R. C. Emmons, Carl Tolman.
- 1940 Arthur P. Honess, R. C. Emmons, Carl Tolman, D. Jerome Fisher.
- 1941 R. C. Emmons, Carl Tolman, D. Jerome Fisher, Martin A. Peacock.
- 1942 Carl Tolman, D. Jerome Fisher, Martin A. Peacock, Adolf Pabst.

ANNUAL MEETING PLACES

- | | |
|-----------------------------|-------------------------------|
| 1920 Chicago, Illinois | 1932 Cambridge, Massachusetts |
| 1921 Amherst, Massachusetts | 1933 Chicago, Illinois |
| 1922 Ann Arbor, Michigan | 1934 Rochester, New York |
| 1923 Washington, D. C. | 1935 New York, N. Y. |
| 1924 Ithaca, New York | 1936 Cincinnati, Ohio |
| 1925 New Haven, Connecticut | 1937 Washington, D. C. |
| 1926 Madison, Wisconsin | 1938 New York, N. Y. |
| 1927 Cleveland, Ohio | 1939 Minneapolis, Minnesota |
| 1928 New York, N. Y. | 1940 Austin, Texas |
| 1929 Washington, D. C. | 1941 Boston, Massachusetts |
| 1930 Toronto, Canada | 1942 No meeting held |
| 1931 Tulsa, Oklahoma | |

CORRESPONDENTS, FELLOWS, MEMBERS AND SUBSCRIBERS OF THE MINERALOGICAL SOCIETY OF AMERICA

CORRESPONDENTS

- ESKOLA, PENTTI, Geological Survey of Finland, Helsingfors, Finland.
 FERSMAN, A. E., Geological and Mineralogical Museum, Academy of Science, Leningrad,
 U.S.S.R.
 LACROIX, A., Museum of Natural History, Paris, France.
 NIGGLI, PAUL, Technical High School, Zurich, Switzerland.
 SLAVIK, FRANTISEK, Charles University, Prague VI, Czechoslovakia.
 SPENCER, L. J., 111 Albert Bridge Road, London, S.W. 11, England.
 TILLEY, C. E., Cambridge University, Cambridge, England.

FELLOWS AND MEMBERS

(* Indicates Fellow)

- *ADAMS, ELLIOT Q., Lamp Development Laboratory, Nela Park, Cleveland, Ohio.
 ADAMS, JOHN W., Empire Zinc Company, Hanover, New Mexico.
 *AGAR, WILLIAM M., 32 East 51 Street, New York, New York.
 AGRELL, S. O., Department of Geology, University of Manchester, Manchester, 13, Eng-
 land.
 *AHLFELD, FRIEDRICH, Casilla 873, La Paz, Bolivia.
 *ALDRICH, HENRY R., 419 West 117 Street, New York, New York.
 ALEXANDER, A. E., 155 East 47 Street, New York, New York.
 ALF, RAYMOND M., Webb School, Claremont, California.
 ALLEN, C. M., Bay House, Pembroke, Bermuda.
 *ALLEN, VICTOR T., St. Louis University, St. Louis, Missouri.
 *ALLING, HAROLD L., 31 Barrington Street, Rochester, New York.
 ANDERSON, CHRIS S., Route 1, Box 111, Selma, California.
 *ANDERSON, CHARLES A., Department of Geology and Mineralogy, University of California,
 Berkeley, California.
 *ANDERSON, GEORGE H., Texas Power and Light Co., 710 Interurban Building, Dallas,
 Texas.
 ANDERSON, J. L., Department of Geology, Johns Hopkins University, Baltimore, Mary-
 land.
 ANDERSON, KEITH, U. S. Geological Survey, Geology Annex, Iowa City, Iowa.
 ANDERSON, RICHARD J., Arkansas Geological Survey, Little Rock, Arkansas.
 ANDREW, GERALD, Box 244, Khartoum, Anglo-Egyptian Sudan, Africa.
 ANDREWS, T. G., University of Alabama, University, Alabama.
 ARMSTRONG, ELIZABETH, Department of Geology, Columbia University, New York,
 N. Y.
 ASHBY, D. F., Department of Geology, The University, Bristol, 8, England.
 *ASHCROFT, FREDERICK N., Department of Mineralogy, University Museum, Oxford,
 England.
 AYRES, VINCENT L., Michigan College of Mines and Technology, Houghton, Michigan.

 BAILEY, A. M., Colorado Museum of Natural History, City Park, Denver, Colorado.
 BAILEY, EDGAR H., U.S.G.S., Box 122, Healdsburg, California.
 BAILEY, E. M., Andover, Maine.

- *BAIN, GEORGE W., 12 Dana Street, Amherst, Massachusetts.
BALDINELLI, J., Diagonal Norte 567, Buenos Aires, Argentina, South America.
BALES, C. E., Ironton Firebrick Co., Ironton, Ohio.
BALKE, CLAIRE C., 2458 Estes Avenue, Chicago, Illinois.
BALSLEY, J. R., Jr., U. S. Geological Survey, Washington, D. C.
*BANDY, M. C., Patino Mines and Enterprises, Siglo XX, Llallagua, Bolivia, South America.
BANK, A. C., Holden, Washington.
*BANNERMAN, HAROLD M., Dartmouth College, Hanover, New Hampshire.
*BANNISTER, F. A., 34 Monahan Avenue, Purley, Surrey, England.
BARCANTE, ITAGIBA, Director do Servico de Informacoes Agricolas do Ministerio da Agricultura, Rio de Janeiro, Brazil, South America.
BARCLAY, GEORGE C., P.O. Box 314, Newport News, Virginia.
BARLETT, HELEN BLAIR, A-C Spark Plug Company, Flint, Michigan.
BARRETT, RICHARD L., 1502 East 118 Street, Cleveland, Ohio.
*BARTH, TOM F. W., Mineralogisk Institut, Blindern, Oslo, Norway.
*BASCOM, FLORENCE, Williamstown, Massachusetts.
*BASTIN, EDSON S., University of Chicago, Chicago, Illinois.
*BATEMAN, ALAN M., Yale University, New Haven, Connecticut.
BATES, THOMAS F., Department of Geology, Pennsylvania State College, State College, Pennsylvania.
*BAUER, LAWSON H., New Jersey Zinc Company, Franklin, New Jersey.
BEAL, I. A., Route 1, Box 615, Campbell, California.
BEARD, E. H., The Imperial Institute, London, S.W. 7, England.
*BEHRE, CHARLES H., Columbia University, New York, New York.
BELL, GORDON L., 485 Elwood Avenue, Oakland, California.
BELL, JAMES FORBES, Misc. Minerals, WPB, Temporary "R" Building, Washington, D. C.
BENNER, R. C., Research Laboratory, Carborundum Company, Niagara Falls, New York.
BERG, GEORGE N., MM1c, USN, USS Russell, c/o Fleet PO, San Francisco, California.
BERKELHAMER, LOUIS H., Southern Experiment Station, U. S. Bureau of Mines, Tuscaloosa, Alabama.
*BERMAN, HARRY, 12 Geological Museum, Harvard University, Cambridge, Massachusetts.
BERNHEIMER, ALAN W., Department of Bacteriology, New York University College of Medicine, 477 First Avenue, New York, New York.
*BERRY, LEONARD G., 89 Dewson Street, Toronto, Canada.
BETZ, FREDERICK, JR., U. S. Bureau of Mines, Washington, D. C.
*BILLINGS, MARLAND P., Harvard University, Cambridge, Massachusetts.
BINGHAM, E. BURRIS, 936½ West 76 Street, Los Angeles, California.
BIREN, MRS. HELEN A., Brooklyn College, Brooklyn, New York.
BJAREBY, GUNNAR, 147 Worthington Street, Boston, Massachusetts.
BLANK, HORACE R., Soil Conservation Service, Box 26, Waco, Texas.
BOGUE, RICHARD G., 404 Rutherford Avenue, Franklin, New Jersey.
BOKOVVOY, SAMUEL, 75 Elmwood Road, Verona, New Jersey.
*BOWEN, NORMAN L., University of Chicago, Chicago, Illinois.
*BOWLES, OLIVER, U. S. Bureau of Mines, Washington, D. C.
BOZBAG, HAMDİ, General Delivery, Climax, Colorado.
BRADLEY, W. F., Illinois State Geological Survey, Urbana, Illinois.
BRAISLIN, DANA D., JR., 2615 Las Lunas, Pasadena, California.
*BRAMLETTE, MILTON N., Department of Geology, University of California at Los Angeles, California.

- BRANT, ARTHUR M., Lord Hall, Ohio State University, Columbus, Ohio.
- BRAY, JOSEPH M., Lt., Garden City Hotel, Garden City, Long Island, New York.
- BRINEMAN, JOHN H., Escuela de Geologia, Caracas, Venezuela.
- BRIXEY, A. D., JR., Hales Bar Dam, Guild, Tennessee.
- BROWN, GROVE E., 4915 Agnes Avenue, North Hollywood, California.
- BROWN, W. R., Virginia Geological Survey, Charlottesville, Virginia.
- *BRUCE, E. L., Queen's University, Kingston, Ontario, Canada.
- BRYANT, W. M. D., R.F.D. 3, Silverside Road, Wilmington, Delaware.
- BUCKELEW, HAROLD C., 1048 Broad Street, Newark, New Jersey.
- *BUDDINGTON, ARTHUR F., Princeton University, Princeton, New Jersey.
- *BUERGER, MARTIN J., Massachusetts Institute of Technology, Cambridge, Massachusetts.
- *BUERGER, NEWTON W., Department of Metallurgy, U. S. Naval Academy, Annapolis, Maryland.
- BUIE, BENNETT FRANK, Box 951, Warrenton, Virginia.
- *BULLARD, FRED M., 903 West 30 Street, Austin, Texas.
- BUNTON, PAUL B., 5 Plaza Way, S. W., Atlanta, Georgia.
- BURANEK, ALFRED M., 1166 East 6th Street, South, Salt Lake City, Utah.
- *BURBANK, WILBUR S., U. S. Geological Survey, Washington, D. C.
- BURFOOT, JAMES D., JR., Cornell University, Ithaca, New York.
- *BUTLER, G. MONTAGUE, University of Arizona, Tucson, Arizona.
- BUTLER, JOHN W., JR., Apartado Aereo 3577, Bogota, Colombia, South America.
- *BUTLER, ROBERT D., 215 George Mason Road, Falls Church, Virginia.
- CALLAHAN, WILLIAM H., Franklin, New Jersey.
- CALVER, JAMES L., TVA, 601 Arnstein Building, Knoxville, Tennessee.
- CAMERON, EUGENE N., Columbia University, New York, New York.
- *CAMPBELL, CHARLES D., Harvey Road, RR 1, Pullman, Washington.
- *CAMPBELL, IAN, California Institute of Technology, Pasadena, California.
- CANNON, RALPH S., JR., U. S. Geological Survey, Washington, D. C.
- CAPLAN, ALLAN, Room 906, 562 Fifth Avenue, New York, New York.
- CAPPS, MRS. EDNA WARD, 1823 Jefferson Place, N.W., Washington, D. C.
- CARL, HOWARD F., 1844 Ontario Place, N.W., Washington, D. C.
- CHAPMAN, CARLETON A., Department of Geology, University of Illinois, Urbana, Illinois.
- CHAPMAN, ERNEST W., 1934 Mill Road, South Pasadena, California.
- *CHAPMAN, RANDOLPH, Department of Geology, Johns Hopkins University, Baltimore, Maryland.
- CHAYES, FELIX, 4104 Queensbury Road, Hyattsville, Maryland.
- CHESLEY, FRANK G., Massachusetts Institute of Technology, Cambridge, Massachusetts.
- CHESTERMAN, CHARLES W., 1311 Beale Avenue, Bakersfield, California.
- CHRISTENSEN, TOM, Box 1676, Fairbanks, Alaska.
- CHUTE, NEWTON E., General Delivery, Globe, Arizona.
- CISTAR, LOUIS A., 129 Avenue B, Rochester, New York.
- CLAFFY, MRS. ESTHER M., Room G-241-C, U. S. Geological Survey, Washington, D.C.
- COATS, ROBERT, Alaskan Branch, U. S. Geological Survey, Washington, D.C.
- *COLBURN, BURNHAM S., Greystone Court, Biltmore, North Carolina.
- *COLBURN, WILLIAM B., 333 Washington Road, Grosse Pointe, Michigan.
- *CONNOLLY, JOSEPH P., 1804 West Boulevard, Rapid City, South Dakota.
- COOK, KATHRYN H., 493 South Firestone Boulevard, Akron, Ohio.
- *COOKE, S. R. B., Montana School of Mines, Butte, Montana.
- COOLEY, MARY E., 793 South Forest Avenue, Ann Arbor, Michigan.

- COOPER, JOHN R., U. S. Geological Survey, 707 Peyton Building, Spokane, Washington.
- *CORBETT, CLIFTON S., 57 Sunnywood Drive, Westfield, New Jersey.
- CORBIN, L. P. JR., 210 Tyler Street, Sandusky, Ohio.
- COURTRIGHT, HUGH C., 4940 East End Avenue, Chicago, Illinois.
- CRAMER, JOE L., 140 North Kansas, Wichita, Kansas.
- CRAWFORD, ARTHUR L., 1067 East Fifth Street South, Salt Lake City, Utah.
- *CRAWFORD, R. D., 1050 Tenth Street, Boulder, Colorado.
- CRESS, SAMUEL H., 1648 Park Road, N.W., Washington, D. C.
- CRICKMAY, GEOFFREY W., Box 549, Athens, Georgia.
- CRIPPEN, RICHARD A., Idria, San Benito County, California.
- CRUNDEN, A. B., 54 Edgemont Road, Montclair, New Jersey.
- CUMMINS, A. B., 602 East Front Street, Plainfield, New Jersey.
- *CURRIER, LOUIS W., U. S. Geological Survey, Washington, D.C.
- CUTHBERT, F. LEICESTER, Natural Resources Building, University of Illinois, Urbana, Illinois.
- DAKE, H. C., 703 Couch Building, Portland, Oregon.
- DALEY, A. COWLES, 1191 North Los Robles, Pasadena, California.
- DARNEAL, ROBERT L., Box 151, Cloverdale, California.
- DAVIDSON, STANLEY C., 152 Wembley Drive, Sudbury, Ontario, Canada.
- DAVIS, DONALD W., Scarsdale Manor Apts., R-North, Scarsdale, New York.
- DAVIS, HARRY T., North Carolina State Museum, Raleigh, North Carolina.
- DENNING, REYNOLDS M., 843 Thurston Road, Rochester, New York.
- DENNIS, WILLIAM ENGS, JR., Box 373, Newport, Rhode Island.
- DENNEY, M. V., Mineralogical Laboratory, University of Michigan, Ann Arbor, Michigan.
- DERR, HERMAN, 329 N.W. 13 Street, Oklahoma City, Oklahoma.
- DIETZ, ROBERT S., Army Air Force Navigation School, Hondo, Texas.
- DODGE, THEODORE A., Cananea Consolidated Copper Company, Cananea, Sonora, Mexico.
- *DONNAY, JOSEPH D. H., Hercules Powder Company, Wilmington, Delaware.
- DOTEN, ROBERT K., Basin Farm, Brandon, Vermont.
- DOUGLAS, GORDON S., 2201 Georgina Avenue, Santa Monica, California.
- DRAISIN, WILBUR M., Majestic Radio & Television Company, 2600 West 50 Street, Chicago, Illinois.
- DRAKE, HARRY Y., 44 Laurel Avenue, East Orange, New Jersey.
- *ECKEL, EDWIN B., U. S. Geological Survey, Washington, D.C.
- EDMUNDSON, R. S., Virginia Geological Survey, Box 1428, University Station, Charlottesville, Virginia.
- EGGLESTON, JULIUS W., Cuttingsville, Vermont.
- EHRMANN, MARTIN L., CAPT., 3900 Greystone Avenue, Riverdale, New York.
- *ELLSWORTH, H. V., Canada Geological Survey, Ottawa, Canada.
- ELWELL, WILBUR J., 2 Duck Street, Danbury, Connecticut.
- EMERY, ALDEN H., 1155 16th Street, N.W., Washington, D.C.
- *EMMONS, RICHARD C., University of Wisconsin, Madison, Wisconsin.
- *ENGLISH, GEORGE L., 50 Brighton Street, Rochester, New York.
- EVANOFF, PHILIP, 2537 North Natrona Street, Philadelphia, Pennsylvania.
- EVANS, MRS. DAVID L., 137 Plant Avenue, Webster Groves, Missouri.
- EVANS, HOWARD T., JR., 850 Massachusetts Avenue, Apt. 10, Cambridge, Massachusetts.
- EVERS, JOHN R., 19 South Broadway, Tarrytown, New York.

- FAESSLER, CARL, Bibliotheque "D," Faculte des Sciences, Boulevard de l'Entente, Quebec, Canada.
- *FAHEY, JOSEPH J., U. S. Geological Survey, Washington, D.C.
- *FAIRBAIRN, HAROLD W., Massachusetts Institute of Technology, Cambridge, Massachusetts.
- *FAIRCHILD, JOHN G., U. S. Geological Survey, Washington, D.C.
- *FAUST, GEORGE T., 1803 Capitol View Avenue, Silver Springs, Maryland.
- *FENNER, CLARENCE N., 64 Broad Street, Clifton, New Jersey.
- FERGUSON, R. B., Department of Mineralogy, University of Toronto, Toronto, Canada.
- *FETTKE, CHARLES R., 1118 Wightman Street, Squirrel Hill Station, Pittsburgh, Pennsylvania.
- *FISHER, D. JEROME, University of Chicago, Chicago, Illinois.
- *FISHER, LLOYD W., Bates College, Lewiston, Maine.
- FISK, HENRY G., 2261 West 120 Street, Blue Island, Illinois.
- FLACK, WYLIE H., 609 Maple Avenue, LaPorte, Indiana.
- FLAGG, A. L., Box 2345, Phoenix, Arizona.
- FLEENER, F. L., Joliet Junior College, Joliet, Illinois.
- FLEISCHER, ARTHUR, 1021 East South Temple Street, Salt Lake City, Utah.
- *FLEISCHER, MICHAEL, U. S. Geological Survey, Washington, D.C.
- FOLINSBEE, ROBERT E., Geological Survey of Canada, Ottawa, Canada.
- FOOTE, FREEMAN, Williams College, Williamstown, Massachusetts.
- *FORD, HUGH ALEXANDER, British Consul General, 57 Larchwood Drive, Cambridge, Massachusetts.
- *FOSHAG, WILLIAM F., U. S. National Museum, Washington, D.C.
- FOSTER, GIRAUD V., 1088 Park Avenue, New York, New York.
- FOSTER, MARGARET D., U. S. Geological Survey, Washington, D.C.
- FOSTER, PHILIP C., R.D. 1, South Berwick, Maine.
- FOSTER, WILDER D., 4800 Forbes Street, Pittsburgh, Pennsylvania.
- FOSTER, WILFRID R., Champion Spark Plug Company, 8525 Butler Avenue, Detroit, Michigan.
- FOX, PORTLAND P., Box 31, Charleston, Tennessee.
- FRANCKE, A., 6 Bubenberplatz, Bern, Switzerland.
- *FRASER, DONALD M., Bethlehem Steel Company, Bethlehem, Pennsylvania.
- *FRASER, HORACE J., California Institute of Technology, Pasadena, California.
- FRASER, R. J., JR., 3020 Andrita Street, Los Angeles, California.
- FREEZE, ARTHUR C., Kimberley, British Columbia, Canada.
- FRETZ, A. HENRY, 42 West Market Street, Bethlehem, Pennsylvania.
- FRIES, CARL, JR., U. S. Geological Survey, Washington, D. C.
- *FRONDEL, CLIFFORD, 22 8 Street, N.E., Washington, D.C.
- FRUEH, ALFRED J., JR., 34 Perry Street, New York, New York.
- *FULLER, RICHARD E., 1642 Federal Avenue, Seattle, Washington.
- FUNK, B. GORDON, 2667½ Waverly Drive, Los Angeles, California.
- GABRIEL, ALTON, U. S. Bureau of Mines, College Park, Maryland.
- *GAGE, R. B., Box 199, Trenton, New Jersey.
- GALBRAITH, F. W., University of Arizona, Tucson, Arizona.
- GALLAGHER, David, 349 Clark Road, Brookline, Massachusetts.
- GALLONI, E., Granaderos 155, Buenos Aires, Argentina, South America.
- GATES, ELLIS H., Cerro de Pasco Corp., La Oroya, Peru.
- GATES, GEORGE O., Alaskan Branch, U. S. Geological Survey, Washington, D. C.

- GATES, ROBERT M., 410 South Orchard Street, Madison, Wisconsin.
- GAULT, H. RICHARD, Alaskan Branch, U. S. Geological Survey, Washington, D.C.
- GEORGE, D'ARCY R., 117 Haws Avenue, Norristown, Pennsylvania.
- GERSON, FRED, 5421 Cornell Street, Hyde Park Station, Chicago, Illinois.
- *GIANELLA, VINCENT P., Mackay School of Mines, Reno, Nevada.
- GIBSON, J. C., Bissett, Manitoba, Canada.
- GILLESPIE, T. B., Palatka, Florida.
- GILLINGHAM, THOMAS E., 308 West Wilson Street, Madison, Wisconsin.
- *GILLSON, JOSEPH L., 8063 Du Pont Building, Wilmington, Delaware.
- *GILLULY, JAMES, University of California at Los Angeles, California.
- *GLASS, JEWELL J., U. S. Geological Survey, Washington, D.C.
- GODDARD, E. N., U. S. Geological Survey, Washington, D.C.
- GOETTMAN, FRANKLIN P., 1121 Queen Street, Pottstown, Pennsylvania.
- *GOLDICH, SAMUEL S., Agricultural and Mechanical College of Texas, College Station, Texas.
- GOLDRING, EWART D., c/o Vanadium Corporation of America, Naturita, Colorado.
- GOMEZ, E., Diagonal Norte 567, Buenos Aires, Argentina, South America.
- GODMAN, CLARK, 77 Massachusetts Avenue, Cambridge, Massachusetts.
- *GOODSPEED, GEORGE E., University of Washington, Seattle, Washington.
- *GORDON, SAMUEL G., Philadelphia Academy of Natural Sciences, Logan Circle, Philadelphia, Pennsylvania.
- GOUDEY, HATFIELD, Box 401, Yerington, Nevada.
- GOULETTE, C. HENRY, Lt., Company G, 50th A. I. R., Camp Campbell, Kentucky.
- GRABER, B. P., 115 Coolidge Avenue, Barrington, Illinois.
- *GRAHAM, R. P. D., McGill University, Montreal, Canada.
- GRAHL, HARRY, 885 Cauldwell Avenue, Bronx, New York.
- *GRATON, LOUIS C., Harvard University, Cambridge, Massachusetts.
- GRAVES, HOWARD B., JR., 1454 Jackson Avenue, Apt. 2, Memphis, Tennessee.
- GRAWE, OLIVER R., Missouri School of Mines, Rolla, Missouri.
- GRAY, HERBERT, 400 Irving Avenue, Brooklyn, New York.
- GRIEGER, J. M., 405 Ninia Parkway, Pasadena, California.
- *GRIM, RALPH E., Illinois Geological Survey, Urbana, Illinois.
- *GROUT, FRANK F., University of Minnesota, Minneapolis, Minnesota.
- *GRUNER, JOHN W., University of Minnesota, Minneapolis, Minnesota.
- GULOVSON, MRS. C. M., Brothers, Oregon.
- GUMMER, WILFRID K., 815 Fifth Street, Arvida, Quebec, Canada.
- *GYSIN, M. E., Laboratoire de Mineralogie de l'Universite, Quai de l'Ecole-de-Medecin, Geneva, Switzerland.
- HAFF, JOHN C., Colorado School of Mines, Golden, Colorado.
- HAGNER, ARTHUR F., University of Wyoming, Laramie, Wyoming.
- HALBOUTY, M. T., No. 5 West Lane, Houston, Texas.
- HALL, F. P., R.F.D. 2, Syracuse, New York.
- HANLEY, JOHN B., U. S. Geological Survey, Box 147, Golden, Colorado.
- *HARCOURT, GEORGE A., Copper Cliff, Ontario, Canada.
- HATCH, ROBERT A., Corning Glass Works, Corning, New York.
- HAUZE, GEORGE E., P.O. Box 326, Fairlawn, New Jersey.
- *HAWKINS, A. C., 208 West Boscawen Street, Winchester, Virginia.
- *HAWLEY, James E., Queen's University, Kingston, Ontario, Canada.
- HAYES, JUNIUS J., 1148 East First Street South, Salt Lake City, Utah.

- HEINEMAN, ROBERT E. S., 20 Calle Conquista, Tucson, Arizona.
- *HENDERSON, EDWARD P., U. S. National Museum, Washington, D.C.
- *HENDRICKS, STERLING B., 3045 Albemarle Street, N.W., Washington, D. C.
- *HESS, FRANK L., 1221 Newton Street, N.E., Washington, D.C.
- *HESS, HARRY H., Princeton University, Princeton, New Jersey.
- *HEWETT, D. F., U. S. Geological Survey, Washington, D.C.
- HEWITT, D. F., 95 Balsam Avenue, South, Hamilton, Ontario, Canada.
- HEYL, ALLEN V., JR., R.F.D. 2, Allentown, Pennsylvania.
- HEYL, GEORGE R., Box 324, Jackson, California.
- HICKOK, WILLIAM O., IV, R.F.D. 1, Linglestown, Pennsylvania.
- HILL, H. STANTON, Pasadena Junior College, Pasadena, California.
- HILLS, RALPH F., 35 Manchester Street, Hartford, Connecticut.
- HILLS, THOMAS M., Vassar College, Poughkeepsie, New York.
- HINCKLEY, ARTHUR T., 937 Harrison Avenue, Niagara Falls, New York.
- *HODGE, EDWIN T., 2915 Luray Terrace, N.W., Portland, Oregon.
- *HOLDEN, GUERDON S., Plain Dealer Building, Cleveland, Ohio.
- *HOLMES, ARTHUR, Science Laboratory, South Road, Durham, England.
- HOLMES, RALPH J., Columbia University, New York, New York.
- HOOKER, MARJORIE, 32-14 146 Street, Flushing, New York.
- HOSE, HEATH ROYDON, Aluminium Laboratories, 1800 Sun Life Building, Montreal, Quebec, Canada.
- HOWLAND, ARTHUR L., Northwestern University, Evanston, Illinois.
- HUGILL, WILLIAM, Langham House, Fields Road, Alsager, Cheshire, England.
- *HUNT, WALTER F., University of Michigan, Ann Arbor, Michigan.
- *HURLBUT, C. S., JR., Harvard University, Cambridge, Massachusetts.
- HUSTED, JOHN E., 1448 Girard St., N.W., Washington, D. C.
- HUTTON, C. OSBORNE, 156, The Terrace, Wellington, New Zealand.
- *INGERSON, EARL, Geophysical Laboratory, Washington, D.C.
- *INSLEY, HERBERT, Bureau of Standards, Washington, D.C.
- IRWIN, WILLIAM H., 215 East 19 Avenue, Denver, Colorado.
- JACOBS, ELBRIDGE C., University of Vermont, Burlington, Vermont.
- JACOBS, LOUIS J., 6153 North Legett Avenue, Chicago, Illinois.
- JAE, JAMES F., 5510 Waterman Boulevard, St. Louis, Missouri.
- JARRELL, O. W., 3960 Pennsylvania Avenue, S.E., Washington, D.C.
- JEFFRIES, CHARLES D., Department of Agronomy, Agricultural Building, State College, Pennsylvania.
- JENSEN, DAVID E., 90 Middlesex Road, Rochester, New York.
- JENSEN, NAN C., 1505 North Scott Street, Arlington, Virginia.
- JILES, CARLOS PIZARRO, Braden Copper Company, Sewell (Rancagua), Chile.
- *JOHANNSEN, ALBERT, University of Chicago, Chicago, Illinois.
- JOHANSSON, FREDERICK V., 96 Boutelle St., Leominster, Massachusetts.
- JOHNSON, J. HARLAN, Box 343, Golden, Colorado.
- JOHNSON, W. M., Route 4, Knoxville, Tennessee.
- *JOHNSTON, R. A. A., 112 Old Forest Hill Road, Toronto 10, Canada.
- *JOHNSTON, WILLIAM D., JR., U. S. Geological Survey, Washington, D.C.
- *JOLLIFFE, ALFRED W., Canada Geological Survey, Ottawa, Canada.
- *JONES, GARDNER H., 8 Hill Street, Lakeport, New Hampshire.
- JONES, KENT, 2406 Connor Avenue, Joplin, Missouri.

- JONES, R. E., New Wilmington, Pennsylvania.
- JUDD, E. F., 14 Bruce Road, Upper Montclair, New Jersey.
- KARLSSON, ALBERT, 3042 Grand Concourse, New York, New York.
- KASSNER, MYER J., 628 Main Street, Laconia, New Hampshire.
- KAUFFMAN, A. J., JR., 4205 Russell Avenue, Mt. Rainier, Maryland.
- KELLER, W. D., 208 Swallow Hall, Columbia, Missouri.
- KENNEDY, GEORGE C., U. S. Geological Survey, Washington, D. C.
- KEPPEL, DAVID, Montrose, New York.
- *KERR, PAUL F., Columbia University, New York, New York.
- KERR-LAWSON, MRS. FERGA C., Box 5, Swastika, Ontario, Canada.
- KESSLER, CHARLES N., No. 3 Berg Apts., Helena, Montana.
- KILMER, CHARLES, 1338 Park Avenue, River Forest, Illinois.
- KIPNIS, JOSEPH S., 15 West 46 Street, New York, New York.
- *KLEIN, A. A., Norton Company, Worcester, Massachusetts.
- KNABE, WILLIAM C., 3853 North Gratz Street, Philadelphia, Pennsylvania.
- *KNOPF, ADOLPH, Yale University, New Haven, Connecticut.
- *KOSCHMANN, A. H., U. S. Geological Survey, Washington, D.C.
- *KRAUS, EDWARD H., University of Michigan, Ann Arbor, Michigan.
- *KRISHNAN, M. S., 27 Chowringhee, Calcutta, India.
- KUENSTLER, WALTER E., 410 Lafayette Avenue, Grantwood, New Jersey.
- KURBATOV, J. D., Ohio State University, Columbus, Ohio.
- LAMONT, ALEX J., Nenana, Alaska.
- *LANDES, KENNETH K., University of Michigan, Ann Arbor, Michigan.
- *LANE, ALFRED C., 22 Arlington Street, Cambridge, Massachusetts.
- LANGFORD, LAWRENCE, 949 Krameria Street, Denver, Colorado.
- *LARSEN, ESPEER S., JR., 59 Orchard Street, Belmont, Massachusetts.
- LARSEN, ESPEER S., 3rd, 8501 Greenwood Avenue, Takoma Park, Maryland.
- LAUSEN, CARL, 1299, Albuquerque, New Mexico.
- *LEE, HARLEY C., Basic Magnesium, Inc., Box MM, Boulder City, Nevada.
- *LEE, O. IVAN, 2684 Boulevard, Jersey City, New Jersey.
- LEE, ORVILLE D., Box 978, Del Rio, Texas.
- LEINEWEBER, I. A., 2718 Bainbridge Avenue, Bronx, New York.
- LEMCKE, W. L., 609 14 Street, Franklin, Pennsylvania.
- LEMKE, RICHARD W., 363 North Glebe Road, Arlington, Virginia.
- LEMMON, DWIGHT M., 2180 Bryant Street, Palo Alto, California.
- LEVIN, S. BENEDICT, 695 Park Avenue, New York, New York.
- LEWIS, FRANK A., 721 East 35 Street, Brooklyn, New York.
- LEWIS, W. SCOTT, 2500 North Beachwood Drive, Hollywood, California.
- DE LIMA, PLINIO, Rua Vitorino Carmillo 565, Sao Paulo, Brazil.
- LOMERSON, WILLIAM W., Shore Road, New Rochelle, New York.
- *LONSDALE, JOHN T., Lt. Col., 1910 40 Street, Des Moines, Iowa.
- *LOPEZ, VICTOR M., Servicio Tecnico de Geologia, Caracas, Venezuela.
- *LOUNDERBACK, GEORGE D., University of California, Berkeley, California.
- *LOUGHLIN, G. F., U. S. Geological Survey, Washington, D.C.
- *LOVERING, T. S., University of Michigan, Ann Arbor, Michigan.
- LOWE, KURT E., Lt., 196 Rockaway Parkway, Brooklyn, New York.
- LUKESH, JOSEPH S., 374 Norwood Avenue, Long Branch, New Jersey.

- LYON, JENNINGS, Officer Candidate School, Chemical Warfare Service, Edgewood Arsenal, Maryland.
- LYONS, ERWIN J., Wisconsin Institute of Technology, Platteville, Wisconsin.
- MACDONALD, GORDON A., Geological Survey, 333 Federal Building, Honolulu, Hawaii.
- MACKAY, RALPH E., 2923 East Harrison Street, Seattle, Washington.
- MACKENZIE, G. S., Department of Geology, University of New Brunswick, Fredericton, New Brunswick, Canada.
- *MANCHESTER, JAMES G., Hampton Bays, Long Island, New York.
- *MARBLE, JOHN P., 37 East Bradley Lane, Chevy Chase, Maryland.
- MARSHALL, E. M., Bethel, Connecticut.
- *MARTENS, JAMES H. C., 2925 University Avenue, Morgantown, West Virginia.
- MARTIN, E. B., Westbury, Long Island, New York.
- MASON, VINCENT I., 117 Beech Street, Roslindale, Massachusetts.
- *MATHEWS, EDWARD B., Johns Hopkins University, Baltimore, Maryland.
- MATHEWSON, H. D., 1033 Magnolia Avenue, San Bernardino, California.
- MAURICE, CHARLES S., Hanover, New Hampshire.
- MAWBY, M. A., Zinc Corporation, Ltd., Broken Hill, New South Wales, Australia.
- MAYBANK, N. W., Mullard Radio Valve Co. Ltd., New Road, Mitcham Junction, Surrey, England.
- *MAYNARD, JAMES E., Syracuse University, Syracuse, New York.
- *MCCAUGHEY, WILLIAM J., Ohio State University, Columbus, Ohio.
- *MCCONNELL, DUNCAN, Bureau of Reclamation, Customhouse, Denver, Colorado.
- McCULLOUGH, J. L., Independence, California.
- McDONALD, C. V., 827 West 104 Place, Los Angeles, California.
- *McKINSTRY, HUGH E., 1499 Irving St., N.W., Washington, D.C.
- *McLAUGHLIN, DONALD H., University of California, Hearst Mining Building, Berkeley, California.
- McLELLAN, ROY D., American Smelting & Refining Company, Barber, New Jersey.
- McLEOD, EDITH, 413 High Street, Klamath Falls, Oregon.
- *McVAY, THOMAS N., School of Chemistry, University of Alabama, University, Alabama.
- *MEAD, WARREN J., Massachusetts Institute of Technology, Cambridge, Massachusetts.
- *MEEN, V. BEN, University of Toronto, Toronto, Canada.
- MENCHER, ELY, Instituto de Geologia, Avenida San Martin, Caracas, Venezuela.
- MENNINGER, C. F., 3617 West 6th Avenue, Topeka, Kansas.
- *MERRITT, CLIFFORD A., University of Oklahoma, Norman, Oklahoma.
- *MERRITT, PHILLIP L., 11 Lockwood Drive, Old Greenwich, Connecticut.
- *MERTIE, JOHN B., JR., U. S. Geological Survey, Washington, D.C.
- *MERWIN, H. E., Geophysical Laboratory, Washington, D.C.
- MILHORAT, A. T., 525 East 68 Street, New York, New York.
- MILLAR, HUGH H., 3752 Montgomery Avenue, Detroit, Michigan.
- *MILLER, BENJAMIN L., Lehigh University, Bethlehem, Pennsylvania.
- MILLER, FRANKLIN S., 1029 Bryden Road, Columbus, Ohio.
- MILLER, RUDOLPH, Bausch and Lomb Optical Co., 635 Paul Street, Rochester, New York.
- *MILLER, WILLIAM J., University of California at Los Angeles, California.
- MILTON, CHARLES, U. S. Geological Survey, Washington, D.C.
- *MISER, HUGH D., U. S. Geological Survey, Washington, D.C.
- MITCHELL, R. C., 601 Pelham Parkway, N., Bronx, New York.
- MODDLE, D. A., Provincial Assay Office, Department of Mines, Toronto, Canada.
- MONEYMAKER, BERLEN C., 101 Arnstein Building, Knoxville, Tennessee.

- MONTGOMERY, ARTHUR, 1 East 44 Street, New York, New York.
- *MOORE, E. S., University of Toronto, Toronto, Canada.
- MORGAN, LEONARD A., 14 Lincoln Avenue, Dover, New Jersey.
- MORIN, LEO G., Institut de Geologie, Universite de Montreal, 1265 Rue St. Denis, Montreal, Canada.
- *MORRIS, FREDERICK K., Massachusetts Institute of Technology, Cambridge, Massachusetts.
- MORRIS, KENNETH D., Box 221 D2, R.F.D. 5, East Hillsdale Drive, Waukesha, Wisconsin.
- MOYD, LOUIS, Frobisher Exploration Company, Bancroft, Ontario, Canada.
- MURATA, K. J., U. S. Geological Survey, Washington, D.C.
- *MURDOCH, JOSEPH, University of California at Los Angeles, California.
- MURPHY, RICHARD, 244 Bay Street, Toronto, Canada.
- MURRAY, ALBERT N., University of Tulsa, Tulsa, Oklahoma.
- MYERS, V. DALE, 2187 Glen Avenue, Altadena, California.
- *MYERS, WILLIAM M., School of Mineral Industries, Pennsylvania State College, State College, Pennsylvania.
- NAGELSCMIDT, G., Rothamstead Experiment Station, Harpenden, Herts, England.
- NALLE, PETER B., Bethelhem Pike, Whitemarsh, Pennsylvania.
- NEIMAN, ROBERT, 505 East Chestnut Street, Louisville, Kentucky.
- NELSON, FRANK H., 740 North Plankinton Avenue, Milwaukee, Wisconsin.
- NELSON, GAYLORD, 83 Hodge Street, Buffalo, New York.
- NEWCOMET, WILLIAM S., 3501 Baring Street, Philadelphia, Pennsylvania.
- *NEWHOUSE, WALTER H., Massachusetts Institute of Technology, Cambridge, Massachusetts.
- NICHOLS, HENRY W., Field Museum of Natural History, Chicago, Illinois.
- NICHOLS, JOSEPH B., 2914 D Street, Sacramento, California.
- NICHOLS, MAURICE C., 1431 Park Avenue, Long Beach, California.
- NILES, GLENN H., P.O. Box 4, Ridgewood, New Jersey.
- NISSON, WILLIAM H., 815 D Street, Petaluma, California.
- *NOBLE, JAMES A., Homestake Mining Company, Lead, South Dakota.
- *NOLAN, THOMAS B., U. S. Geological Survey, Washington, D.C.
- NORTHUP, M. ALLEN, 10 Godet Place, Morristown, New Jersey.
- NOWACKI, W., Lorystrasse 12, Bern, Switzerland.
- NUTTING, P. G., U. S. Geological Survey, Washington, D.C.
- O'CONNELL, DANIEL T., College of the City of New York, Convent Avenue & 139 Street, New York, New York.
- OKE, WILLIAM C., 9115 South Harvard Boulevard, Los Angeles, California.
- O'LEARY, W. J., Norton Company, Chippawa, Ontario, Canada.
- OLSON, J. C., U. S. Geological Survey, Washington, D.C.
- OSBORN, E. F., Geophysical Laboratory, Washington, D.C.
- OSBORN, J. P., 714 East Boulder, Colorado Springs, Colorado.
- OTERSEN, LILLIAN M., 16 Grove Place, West Haven, Connecticut.
- OVER, EDWIN J., JR., Box 939, Leadville, Colorado.
- *PABST, ADOLF, University of California, Berkeley, California.
- PAGE, LINCOLN R., U. S. Geological Survey, Washington, D.C.
- *PALACHE, CHARLES, 106 Appleton Street, Cambridge, Massachusetts.
- *PARKER, ROBERT L., Technische Hochschule, Zurich, Switzerland.

- PARRISH, WILLIAM, 6156 First Place, N.E., Washington, D.C.
- *PARSONS, ARTHUR L., University of Toronto, Toronto, Canada.
- PARSONS, WILLARD H., National Bureau of Standards, Washington, D.C.
- PATTEN, PHILIP R., 735 Peralta Avenue, Berkeley, California.
- *PEACOCK, MARTIN A., University of Toronto, Toronto, Canada.
- PEARCE, D. W., Purdue University, Lafayette, Indiana.
- PEARL, RICHARD M., 819 South University, Denver, Colorado.
- PECORA, WILLIAM T., U. S. Geological Survey, Washington, D.C.
- *PEGAU, ARTHUR A., Rugby Road, Charlottesville, Virginia.
- *PEOPLES, JOE WEBB, Wesleyan University, Middletown, Connecticut.
- PERHAM, STANLEY I., West Paris, Maine.
- PERIER, GARFIELD B., 804 Diamond Street, Butte, Montana.
- PERRY, ELWYN L., Williams College, Williamstown, Massachusetts.
- PETERSON, HARRY, 1138 South Chapel Street, Alhambra, California.
- PETERSON, NELS P., U. S. Geological Survey, Box 4536, University Station, Tucson, Arizona.
- *PETTIJOHN, FRANCIS J., University of Chicago, Chicago, Illinois.
- PHAIR, GEORGE, Geophysical Laboratory, Washington, D.C.
- PHELPS, WILLARD B., Department of Geology, DePauw University, Greencastle, Indiana.
- PHEMISTER, T. C., University of Aberdeen, Marischal College, Aberdeen, Scotland.
- PHILBRICK, SHAILER S., 426 Walnut Road (2) Ben Avon, Pittsburgh, Pennsylvania.
- PHILBROOK, MRS. P. M., Box 184, Sacramento, California.
- PIERCE, ALBERT C., 606 West 19 Street, Wilmington, Delaware.
- POHL, JOHN C., JR., 204 North Tenth Street, Easton, Pennsylvania.
- POMERANE, JOEL B., Lt., Air Corps, SPAFS, Lubbock, Texas.
- POPE, G. N., 1820 Bay Street, Alameda, California.
- POSTEL, WILLIAM, University of Pennsylvania, Philadelphia, Pennsylvania.
- *POUGH, FREDERICK H., American Museum of Natural History, New York, New York.
- PRINCE, ALAN T., 102 Earnscliffe Avenue, Ottawa, Canada.
- *QUINN, ALONZO W., Brown University, Providence, Rhode Island.
- *QUIRKE, T. T., University of Illinois, Urbana, Illinois.
- RABBITT, JOHN C., 14 Elm Street, Wellesley Hills.
- *RAMSDELL, LEWIS S., University of Michigan, Ann Arbor, Michigan.
- RAYNER, MRS. W. P., 1100 East Magnolia Avenue, El Monte, California.
- REAMER, LOUIS, 336 Elizabeth Street, Orange, New Jersey.
- REEVES, AUGUSTUS, 628 Dooly Block, Salt Lake City, Utah.
- *REINHARD, MAX, Mineralogical Institute, University of Basel, Switzerland.
- REYES, JORGE MUNOZ, Apartado 267, La Paz, Bolivia.
- *RICHMOND, WALLACE E., JR., 2333 South Nash Street, Arlington, Virginia.
- RIDDLE, FRANK H., Champion Spark Plug Company, 8525 Butler Avenue, Detroit, Michigan.
- RIDGE, JOHN D., Lt., C. E. Staff, Engineer School, Fort Belvoir, Virginia.
- *RIES, H., 401 Thurston Avenue, Ithaca, New York.
- RINN, HAROLD W., 2917 Braley Court, Midland, Michigan.
- RITCHIE, EVERETT J., 112 North Byers, Joplin, Missouri.
- ROBERTSON, FORBES, Reynolds Mining Corporation, Boyle Building, Little Rock, Arkansas.
- RODEKOH, W. J., 304 Westminster Avenue, Alhambra, California.

- RODGERS, W. T., 1230 Parkway Avenue, Salt Lake City, Utah.
- ROEDDER, EDWIN, 2630 Yorkway, Dundalk, Maryland.
- *ROGERS, AUSTIN F., Stanford University, California.
- ROLLINS, ROSS, 79 Cypress Street, Brookline, Massachusetts.
- ROSENHOLTZ, JOSEPH L., Rensselaer Polytechnic Institute, Troy, New York.
- ROSENKRANS, R. R., 3 North Meridian Street, Red Key, Indiana.
- *ROSS, CLARENCE S., U. S. Geological Survey, Washington, D.C.
- ROWE, GRANT, 315 South Jefferson Street, Saginaw, Michigan.
- ROWLAND, RICHARDS A., Illinois Geological Survey, Urbana, Illinois.
- RUNNER, DELMAR G., 4606 47 Street, N.W., Washington, D.C.
- *RUNNER, JOSEPH J., Houghton, Michigan.
- *RUTHERFORD, RALPH L., University of Alberta, Edmonton, Alberta, Canada.
- RUTHRUFF, ROBERT F., 1711 West 100 Street, Chicago, Illinois.
- RYNEARSON, GARN A., 14412 Kittridge Street, Van Nuys, California.
- SACHS, WALTER P., 254 Bloomfield Avenue, Caldwell, New Jersey.
- SAFFORD, ARTHUR T., JR., 333 Homestead Avenue, Hartford, Connecticut.
- SALETET, LOUIS, University of Dayton, Dayton, Ohio.
- *SAMPSON, EDWARD, Princeton University, Princeton, New Jersey.
- SAMPTER, E. L., 25 West 46 Street, New York, New York.
- SANDBERG, A. E., Box 413, Cocoli, Canal Zone.
- SANTELL, S. J., General Delivery, Orrick, Missouri.
- SAVAGE, HENRY G., Granite Street, Leominster, Massachusetts.
- *SCHAIKER, JOHN F., Geophysical Laboratory, Washington, D.C.
- *SCHALLER, WALDEMAR T., U. S. Geological Survey, Washington, D.C.
- SCHLECHT, WILLIAM G., U. S. Geological Survey, Washington, D.C.
- SCHLOCKER, J., Box 554, Boulder City, Nevada.
- *SCHMITT, HARRISON A., Box 572, Silver City, New Mexico.
- *SCHNEIDER, HYRUM, University of Utah, Salt Lake City, Utah.
- SCHOENLAUB, R. A., 147 North Washington Street, Tiffin, Ohio.
- *SCHRADER, FRANK C., 20 Old Chester Road, Bethesda, Maryland.
- SCHROETER, JOACHIM, Mineralogical Institute, Federal Polytechnical School, Zurich, Switzerland.
- SCHWARTZ, B., 1884 Monroe Avenue, Bronx, New York.
- *SCHWARTZ, GEORGE M., University of Minnesota, Minneapolis, Minnesota.
- SEGAL, ALLAN, 303 West 2 Street, New York, New York.
- SETZ, C. F., 7720 Club Drive, St. Louis, Missouri.
- SHACKELFORD, G. E., 4340 Fairfax Avenue, Dallas, Texas.
- *SHAND, S. JAMES, Columbia University, New York, New York.
- *SHAUB, BENJAMIN M., 159 Elm Street, Northampton, Massachusetts.
- SHERMAN, WALTER C., 27 Doro Place, Rumford, Rhode Island.
- SHIPTON, W. D., Washington University, St. Louis, Missouri.
- *SHORT, MAX N., University of Arizona, Tucson, Arizona.
- SHORTLE, WALTER, 505 Main Street, Laconia, New Hampshire.
- SIDWELL, RAYMOND, Dept. of Geology, Texas Technological College, Lubbock, Texas.
- SILBERSTEN, M. L., 516 Sul Ross Avenue, Houston, Texas.
- SIMONS, FRANK S., 467 Landfair Street, West Los Angeles, California.
- *SINGEWALD, QUENTIN D., University of Rochester, Rochester, New York.
- SKEA, E. M., Box 46, Pilgrims Rest, Transvaal, South Africa.
- *SLAWSON, CHESTER B., University of Michigan, Ann Arbor, Michigan.

- SMALLING, ELMER, JR., 7029 Lincoln Drive, Philadelphia, Pennsylvania.
 SMITH, D. T., Rensselaer Polytechnic Institute, Troy, New York.
 SMITH, HAROLD M., Cumberland Hill Road, Manville, Rhode Island.
 SMITH, KNOWLES B., University of Notre Dame, Notre Dame, Indiana.
 SMITH, MRS. N. C., 2522 W Street, Sacramento, California.
 SMITH, PETER A., Box 183, Highland Mills, New York.
 SMITH, ROBERT L., Fair Oaks, California.
 SMITH, WALDEN A., Ilwaco, Washington.
 SMITH, WARD, U. S. Geological Survey, Washington, D.C.
 *SNELGROVE, ALFRED K., Michigan College of Mines and Technology, Houghton, Michigan.
 SNIFFEN, E. W., 3111 Chesapeake Ave., Hampton, Virginia.
 SNOW, ROLAND B., Research Laboratory, U. S. Steel Corporation, Kearny, New Jersey.
 SOHLBERG, RUDOLPH G., 225 Bush Street, San Francisco, California.
 *SPENCE, HUGH S., Canada Department of Mines, Ottawa, Canada.
 SPERRY, ARTHUR B., Kansas State College of Agriculture and Applied Science, Manhattan, Kansas.
 SPIROFF, KIRIL, Houghton, Michigan.
 SPROAT, IRA E., Gorham Avenue, Westport, Connecticut.
 STADNICHENKO, TAISIA, U. S. Geological Survey, Washington, D.C.
 *STANTON, GILMAN S., 245 West 104 Street, New York, New York.
 *STAPLES, LLOYD W., University of Oregon, Eugene, Oregon.
 STARBIRD, LEONARD H., 48 Clinton Street, Portland, Maine.
 *STARK, JOHN T., Northwestern University, Evanston, Illinois.
 STEAD, FRANK, 66 East 83 Street, New York, New York.
 *STEIGER, GEORGE, U. S. Geological Survey, Washington, D.C.
 *STEVENS, ROLLIN E., U. S. Geological Survey, Washington, D.C.
 *STEVENSON, JOHN S., Department of Mines, Parliament Buildings, Victoria, British Columbia, Canada.
 STEVENSON, MRS. JOHN S., 1340 Richardson Street, Victoria, British Columbia, Canada.
 *STEWART, DUNCAN, Lehigh University, Bethlehem, Pennsylvania.
 STEWART, SCOTT B., 12 Glenwood Street, Augusta, Maine.
 STIPP, RICHARD A., 7611 Eastern Avenue, Takoma Park, Maryland.
 STOBBE, HELEN, Baldwin House, Northampton, Massachusetts.
 STOIBER, RICHARD E., 3111 20 Street, North, Arlington, Virginia.
 STOLL, WALTER C., 4404 52 Street, N.E., Seattle, Washington.
 *STOW, MARCELLUS H., 4851 21 Road, North, Arlington, Virginia.
 STRINGHAM, BRONSON, University of Utah, Salt Lake City, Utah.
 *STUCKEY, J. L., 1911 Sunset Drive, Raleigh, North Carolina.
 SUDA, JOHN S., Box 1104, Warren, Ohio.
 SWARTZLOW, CARL, Lassen Volcanic National Park, Mineral via Red Bluff, California.
 SWAYNE, W. H., Department of Geology, Anaconda Copper Company, Butte, Montana.
 SWEARENGEN, J. C., Hazel-Atlas Glass Company, Zanesville, Ohio.
 SWITZER, GEORGE, Department of Geology, Yale University, New Haven, Connecticut.
 *TABER, STEPHEN, University of South Carolina, Columbia, South Carolina.
 TATGE, ELEANOR, 5811 14 Street, N.W., Washington, D.C.
 TAYLOR, EDWARD D., Captain, R.C.E., Ken House, Caulfield, British Columbia, Canada.
 TAYLOR, RALPH E., Box 190, Grants Pass, Oregon.

- TEIXEIRA, ORLANDO G., 18 Rua Rio San Francisco, Monte Serrat, Bahia, Brazil.
- TERRILL, ARTHUR C., Box 1150, Las Vegas, Nevada.
- THATCHER, RUSSELL N., 33 Washington Square West, New York, New York.
- THIBAUT, NEWMAN W., Norton Company, Worcester, Massachusetts.
- THOMAS, W. HERSEY, 145 East Gorgas Lane, Mt. Airy, Philadelphia, Pennsylvania.
- THOMPSON, CLYDE L., Harbison Walker Refractories Co., Hays, Pittsburgh, Pennsylvania.
- THOMPSON, M. R., Bureau of Mines, Norris, Tennessee.
- *THOMSON, ELLIS, University of Toronto, Toronto, Canada.
- THUNE, HOWARD W., 302 East 7 Avenue, Tampa, Florida.
- *TOLMAN, CARL, Washington University, St. Louis, Missouri.
- TOMLINSON, W. HAROLD, 260 North Rolling Road, Springfield, Pennsylvania.
- TOOTHAKER, CHARLES R., Commercial Museum, 34 Street and Spruce, Philadelphia, Pennsylvania.
- TRAINER, DAVID W., JR., 48 Payne Street, Hamilton, New York.
- TRAINER, J. N., 233 East 62 Street, New York, New York.
- TREMBLAY, ABBÉ J. A., Seminaire de Chicoutimi, Comte de Chicoutimi, Quebec, Canada.
- TRIMBLE, CLINTON E., 3796 Degnan Boulevard, Los Angeles, California.
- TROTTER, RUSSELL, 129 South Main Street, Windsor Locks, Connecticut.
- TRUDELL, HARRY W., 303 Highland Avenue, Abington, Pennsylvania.
- *TUNELL, GEORGE, Geophysical Laboratory, Washington, D.C.
- TUTHILL, ISABEL H., 1366 Pacific Street, Brooklyn, New York.
- TUTTLE, O. F., Geophysical Laboratory, Washington, D.C.
- UPSON, CHARLES G., R.F.D. 1, Box 150, West Cheshire, Connecticut.
- VALENTINE, WILBUR G., Brooklyn College, Brooklyn, New York.
- VANCE, R. C., Woodland Road, Long Meadow, Pittsford, New York.
- VANDERIKE, PAUL, Route 5, Box 128, Bakersfield, California.
- VERROW, HAROLD J., Gorham, New Hampshire.
- VHAY, JOHN STEWART, U. S. Geological Survey, Washington, D.C.
- VICTORIA, JUAN, Entre Rios 1145, San Juan, Argentina.
- VIETZKE, FRED W. C., 110 West Main Street, Meriden, Connecticut.
- VITALIANO, CHARLES J., Sierra Magnesite Co., Luning, Nevada.
- *VON SCHLICHTEN, OTTO, University of Cincinnati, Cincinnati, Ohio.
- *VONSEN, M., Petaluma, California.
- WADE, F. ALTON, 111 Walnut Street, Oxford, Ohio.
- WAHLSTROM, E. E., University of Colorado, Boulder, Colorado.
- WALDO, ALLEN W., 1335 North Van Buren, Stockton, California.
- WALDSCHMIDT, W. A., 4840 Tennyson Street, Denver, Colorado.
- *WALLACE, ROBERT C., Queen's University, Kingston, Ontario, Canada.
- WALTER, CHARLES, JR., Caprock, New Mexico.
- WALTHER, P., 508 Muriel Parkway, Elizabeth, New Jersey.
- WARNER, ROBERT E., 2980 Pingree Avenue, Detroit, Michigan.
- WARRACH, HENRY C., Box 768, Memphis, Tennessee.
- WASSERSTEIN, B., Geological Survey, Union of South Africa, Pretoria, South Africa.
- *WATSON, E. H., Bryn Mawr College, Bryn Mawr, Pennsylvania.
- WATSON, KENNETH DE P., Department of Mines, Victoria, British Columbia, Canada.
- WAYLAND, RUSSELL G., Capt., 1832 Eye Street, N.W., Washington, D.C.

- WEBB, ROBERT, University of California at Los Angeles, California.
 WEEKS, CHARLES A., Red Gate Lane, Meredith, New Hampshire.
 WEIDHAAS, ERNEST, 63 Iden Avenue, Pelham Manor, New York.
 *WEIDMAN, SAMUEL, 512 Lahoma Street, Norman, Oklahoma.
 WELLMAN, WALTER L., 2205 Alamo Drive, Albuquerque, New Mexico.
 WELLNITZ, ANNA M., Brooklyn College, Brooklyn, New York.
 *WELLS, ROGER C., U. S. Geological Survey, Washington, D.C.
 WERNER, GEORGE R., 229 Whitford Avenue, Nutley, New Jersey.
 WEST, C. D., Polaroid Corporation, 718 Main Street, Cambridge, Massachusetts.
 *WESTGATE, LEWIS G., 124 Oak Hill Avenue, Delaware, Ohio.
 *WHERRY, EDGAR T., 27 Oberlin Avenue, Swarthmore, Pennsylvania.
 WHITAKER, GEORGE C., 825 E. Schaaf Road, R.F.D. 3, Cleveland, Ohio.
 WHITE, GEORGE W., Ohio State University, Columbus, Ohio.
 *WHITLOCK, HERBERT P., American Museum of Natural History, New York, New York.
 WHITNEY, ROSCOE J., Buckingham Road, Leominster, Massachusetts.
 *WIGGLESWORTH, EDWARD, 69 Newbury Street, Boston, Massachusetts.
 WILKINSON, RUSSELL, R. 8, Jackson, Michigan.
 WILLIAMS, H. W., 215 Cedar Street, Corning, New York.
 WILLIAMS, CHARLES R., 27 Thackeray Road, Wellesley Hills, Massachusetts.
 WILLIAMS, NORMAN C., 762 8th Avenue, Salt Lake City, Utah.
 WILLIS, WILLETT R., 1343 North Nevada Avenue, Colorado Springs, Colorado.
 *WINCHELL, ALEXANDER N., University of Wisconsin, Madison, Wisconsin.
 WINCHELL, HORACE, Hamilton Watch Company, Lancaster, Pennsylvania.
 WISHART, JAMES S., 56 Hammond Street, Rochester, New York.
 WITHROW, JAMES R., 77 16 Avenue, Columbus, Ohio.
 *WOLFE, C. W., Boston University, Boston, Massachusetts.
 *WOODFORD, ALFRED O., 443 West 10 Street, Claremont, California.
 WOODHOUSE, C. D., 33 Mimosa Lane, Santa Barbara, California.
 WOODRUFF, T. L., 3480 Morganford Road, St. Louis, Missouri.
 WOODS, ARTHUR E., 115 West Shore Boulevard, Tampa, Florida.
 *WRIGHT, FREDERICK E., 2134 Wyoming Avenue, Washington, D.C.
 WRIGHT, THOMAS A., 1161 Stillman Avenue, Plainsfield, New Jersey.
- YALE, R. B., 6600 Sunset Boulevard, Los Angeles, California.
 YOUNG, B. E., 193 Ridge Road, Grosse Pointe Farms, Michigan.
 YOUNG, FORD, Department of Geology, Columbia University, New York, New York.
 YOUNG, GEORGE, Box 67, Barstow, California.
 YOUNG, JOHN A., JR., Michigan State College, East Lansing, Michigan.
- ZEIHEN, LESTER G., Chile Exploration Company, Chuquicamata, Chile.
 ZEMAN, FREDERIC D., 111 East 88 Street, New York, New York.
 ZERFOSS, SAMUEL, Pennsylvania State College, State College, Pennsylvania.
 ZIMANYI, D. F., Magyar Nemzeti Museum, Budapest, Hungary.
 ZIMMER, PAUL W., Lyon Mountain, New York.
 ZODAC, PETER, Box 29, Peekskill, New York.

SUBSCRIBERS

- Academy of Natural Sciences Library, Logan Circle, Philadelphia, Pennsylvania.
 Agricultural and Mechanical College of Texas Library, College Station, Texas.
 American Colloid Company, 363 West Superior Street, Chicago, Illinois.

- American Cyanamid Company, 1937 West Main Street, Stamford Connecticut.
 American Museum of Natural History Library, New York, New York.
 American Potash and Chemical Corporation, Trona, California.
 American Zinc Company of Tennessee, Geological Department, Mascot, Tennessee.
 Amherst College Library, Amherst, Massachusetts.
 Andhra University Library, Waltair, India.
 Australian Museum, Sydney, New South Wales, Australia.
- Bailey Brothers and Swinfen, Ltd., Cathedral House, 8-11 Paternoster Row, London, E.C. 4, England.
 Bangor Public Library, Bangor, Maine.
 Basic Magnesium, Inc., Box 7, Luning, Nevada.
 Bausch and Lomb Optical Company, Scientific Library, Rochester, New York.
 Beloit College Library, Beloit, Wisconsin.
 Birmingham-Southern College, 900 Eighth Avenue West, Birmingham, Alabama.
 Bonneville Project, Box 3537, Project Library, Portland, Oregon.
 Boston Public Library, Copley Square, Boston, Massachusetts.
 Boston University Library, 688 Boylston Street, Boston, Massachusetts.
 Bridgeport Public Library, 925 Broad Street, Bridgeport, Connecticut.
 Brooklyn Children's Museum Library, Brooklyn, New York.
 Brooklyn Public Library, Science and Industry Division, Brooklyn, New York.
 Brown University Library, Providence, Rhode Island.
 Bryn Mawr College Library, Bryn Mawr, Pennsylvania.
 Buffalo Museum of Science, Research Library, Humbolt Street, Buffalo, New York.
- Caja de Credito Minero, Laboratorio, Casilla 100 D, Santiago, Chile.
 California Institute of Technology, Pasadena, California.
 California State Division of Mines, Ferry Building, San Francisco, California.
 Canadian Industries, Ltd., Development Laboratory, McMasterville, Quebec, Canada.
 Carleton College Library, Northfield, Minnesota.
 Carnegie Institute of Technology, Science Library, Schenley Park, Pittsburgh, Pennsylvania.
 Carnegie Library of Pittsburgh, Schenley Park, Pittsburgh, Pennsylvania.
 Case School of Applied Science, Department of Geology and Mineralogy, Cleveland, Ohio.
 Central Trust of China, 112 Hongkong and Shanghai Bank Building, Hongkong, China.
 Clark University Library, Worcester, Massachusetts.
 Cleveland Public Library, 325 Superior Avenue, N.E., Cleveland, Ohio.
 College of the City of New York, Convent Avenue and 139 Street, New York, New York.
 Colorado College, Coburn Library, Colorado Springs, Colorado.
 Colorado School of Mines Library, Golden, Colorado.
 Colorado Springs Mineralogical Society, 123 North Tejon Street, Colorado Springs, Colorado.
 Columbia University Library, New York, New York.
 Commissioner of Lands and Mines, Georgetown, British Guiana.
 Cornell University Library, Ithaca, New York.
 Cranbrook Institute of Science, Bloomfield Hills, Michigan.
 Crane Company, Research Laboratories, 836 South Michigan Avenue, Chicago, Illinois.
- Dartmouth College Library, Hanover, New Hampshire.
 Denver Public Library, Science and Engineering Department, Denver, Colorado

- Department of Mines, Parliament Buildings, Victoria, British Columbia, Canada.
 Department of Natural Resources, Division of Mines, State Capitol, Atlanta, Georgia.
 Departamento Nacional da Producao Mineral, Avenida Pasteur 404, Rio de Janeiro, Brazil.
 DePauw University Library, Greencastle, Indiana.
 Detroit Public Library, Woodward and Kirby Avenues, Detroit, Michigan.
 Dow Chemical Company Library, Midland, Michigan.
 Dra. Z. Ch. de Cetrangelo, Crisostomo Alvarez 616, Tucuman, Argentina.
 Duke University Library, Durham, North Carolina.
- Earlham College Library, Richmond, Indiana.
 Eastern New Mexico College Library, Portales, New Mexico.
 Ecole Polytechnique, 1430 Rue St. Denis, Montreal, Canada.
 Electro Metallurgical Company, (Union Carbide Laboratories), 4625 Royal Avenue, Niagara Falls, New York.
 Engineering Societies Library, 29 West 39 Street, New York, New York.
 Escola Politecnica da Universidade de Sao Paulo. Rua Quinze de Novembro 144, Sao Paulo, Brazil.
 Escuela de Ingenieros Industriales, Avenida B. O'Higgins 1876, Santiago, Chile.
 Escuela Nacional de Ingenieros, Casilla 1301, Lima, Peru.
- Faxon, F. W., Company, 83 Francis Street, Back Bay, Boston, Massachusetts. (for Alumni Club, Foundation Universitaire, Brussels, Belgium)
 Field Museum of Natural History, Chicago, Illinois.
 Foote Mineral Company, 1609 Summer Street, Philadelphia, Pennsylvania.
 Fresno State Teachers College Library, Fresno, California.
- Garcia, Valentin y Cia. Apartado 2103, Habana, Cuba.
 General Electric Company Laboratory Library, Pittsfield, Massachusetts.
 General Electric Company Research Laboratory Library, Schenectady, New York.
 Geological Society of America, 419 West 117 Street, New York, New York.
 Geological Society of London, Burlington House, Piccadilly, London, W. 1, England.
 Geological Survey, Box 9, Entebbe, Uganda.
 Geological Survey of Canada, Department of Mines and Resources, Victoria Memorial Museum, Ottawa, Canada.
 Geological Survey of Great Britain, Exhibition Road, London, S.W. 7, England.
 Geological Survey of India, 27 Chowringhee Road, Calcutta, India.
 Geological Survey of New Zealand, 156, The Terrace, Wellington, New Zealand.
 Geological Survey of South Africa, Department of Mines, Pretoria, South Africa.
 Geological Survey of Southern Rhodesia, Salisbury, Southern Rhodesia, Africa.
 Geophysical Laboratory, 2801 Upton Street, Washington, D.C.
 Georgia School of Technology Library, Atlanta, Georgia.
 Gobierno de Colombia, Departamento Nacional de Provisiones, Bogota, Colombia.
 Government Mineralogist, Torrington Square, Colombo, Ceylon.
- Hamilton College Library, Clinton, New York.
 Harbison-Walker Refractories Company, Hays Laboratory, Box 443, Homestead, Pennsylvania.
 Harrassowitz, Otto, Braus-Riggenbach, Basel, Switzerland.

- Harvard University, Department of Mineralogy Library, Cambridge, Massachusetts.
 Hazel Atlas Glass Company, Box 94, Wheeling, West Virginia.
 Hebrew University, Department of Geology, Jerusalem, Palestine.
 His Majesty's Stationery Office, Princes Street, Westminster, London, S.W. 1, England.
- I.C.I. Alkali, Ltd., Supply Dept., Northwich, Cheshire, England.
 Idaho University Library, Moscow, Idaho.
 Imperial College of Science and Technology, South Kensington, London, S.W. 7, England.
 Indiana University Library, Bloomington, Indiana.
 Instituto de Geologia, Avenida San Martin, Caracas, Venezuela.
 International Nickel Company of Canada, Ltd., Copper Cliff, Ontario, Canada.
 Iowa State College Library, Ames, Iowa.
- Johannesburg Public Library, Johannesburg, South Africa.
 John Crerar Library, Chicago, Illinois.
 Johns Hopkins University Library, Baltimore, Maryland.
 Johns Manville Research Laboratories, Manville, New Jersey.
- Kansas City Public Library, 9th and Locust Street, Kansas City, Missouri.
 Kansas State Agricultural College Library, Manhattan, Kansas.
- Laboratorio Quimico Nacional, Apartado 2577, Bogota, Colombia.
 Lafayette College Library, Easton, Pennsylvania.
 Lago Petroleum Corporation, Apartado 172, Maracaibo, Venezuela.
 Lehigh University Library, Bethlehem, Pennsylvania.
 Library, Elmwood, Hartburn, Stockton-on-Tees, England.
 Library of Congress, Washington, D. C.
 Linde Air Products Company Library, East Park Drive and Woodward Avenue, Tonawanda, New York.
 Livraria Kosmos, Rua Marconi 91-93, Sao Paulo, Brazil.
 Los Angeles County Public Library, 322 South Broadway, Los Angeles, California.
 Los Angeles Public Library, 5th Street and Broadway, Los Angeles, California.
 Louisiana State University Library, University, Louisiana.
- Maine Mineralogical and Geological Society, 6 Allen Avenue, Portland, Maine.
 Marshall College Library, Huntington, West Virginia.
 Massachusetts Institute of Technology Library, Cambridge, Massachusetts.
 Massachusetts State College, Goodell Library, Amherst, Massachusetts.
 McGill University Library, 3459 McTavish Street, Montreal, Canada.
 McMaster University Library, Hamilton, Ontario, Canada.
 Mechanics Mercantile Library, 57 Post Street, San Francisco, California.
 Mezhdunarodnaja Kniga, Kuznetski Most. 18, Moscow, U.S.S.R.
 Michigan College of Mines and Technology Library, Houghton, Michigan.
 Michigan State College Library, East Lansing, Michigan.
 Ministere Mines and Pecheries, Chambre E-605, Hotel de Government, Quebec, Canada.
 Missouri School of Mines and Metallurgy Library, Rolla, Missouri.
 Montana School of Mines, Butte, Montana.
 Montana State University Library, Missoula, Montana.
 Mount Holyoke College Library, South Hadley, Massachusetts.

- National Institute of Health, Rockville Pike, Bethesda, Maryland.
Nevada Consolidated Copper Corporation, Nevada Mines Division, McGill, Nevada.
Newark Mineralogical Society, 468 Orange Street, Newark, New Jersey.
New Jersey Zinc Company Library, Franklin, New Jersey.
New Jersey Zinc Company, 160 Front Street, New York, New York.
New Mexico State School of Mines, Socorro, New Mexico.
New York Mineralogical Club, Inc., American Museum of Natural History, New York, New York.
New York Public Library, 476 Fifth Avenue, New York, New York.
New York State Library, Albany, New York.
New York University Library, University Heights, New York, New York.
New York University. Washington Square Library, 100 Washington Square East, New York, New York.
Newark Museum Association, 49 Washington Street, Newark, New Jersey.
North American Philips Company, 145 Palisade Street, Dobbs Ferry, New York.
North Carolina State College of Agriculture and Engineering, State College Station, Raleigh, North Carolina.
North Staffordshire Technical College, Ceramic Society, Stoke-on-Trent, England.
North Texas Agricultural College Library, Arlington, Texas.
Northwestern University Library, Evanston, Illinois.
- Oberlin College Library, Oberlin, Ohio.
Occidental College Library, Los Angeles, California.
Ohio State University Library, Columbus, Ohio.
Oklahoma Agricultural and Mechanical College Library, Stillwater, Oklahoma.
Ontario Department of Mines, Parliament Buildings, Toronto, Ontario, Canada.
Oregon State Agricultural College Library, Corvallis, Oregon.
Otago University, Dunedin, New Zealand.
Oxford University, Radcliffe Library, Oxford, England.
- Pasadena Junior College, Hill and Colorado Streets, Pasadena, California.
Pennsylvania State College, School of Mineral Industries, State College, Pennsylvania.
Philadelphia Mineralogical Society, Academy of Natural Science, Logan Circle, Philadelphia, Pennsylvania.
Pomona College Library, Claremont, California.
Princeton University Library, Princeton, New Jersey.
- Queen's University Library, Kingston, Ontario, Canada.
- R. Università, Istituto di Mineralogia, Via dell'Università, 5, Modena, Italy.
Rhode Island State College Library, Green Hall, Kingston, Rhode Island.
Rhodes University College, Grahamstown, South Africa.
Rochester Public Library, 115 South Avenue, Rochester, New York.
Royal Ontario Museum of Mineralogy, 100 Queen's Park, Toronto 5, Canada.
Rumrill, Charles L. and Company, 364 East Avenue, Rochester, New York.
Rutgers University Library, New Brunswick, New Jersey.
- St. Louis University Library, St. Louis, Missouri.
San Diego Society of Natural History, Balboa Park, San Diego, California.
San Diego State College Library, San Diego, California.

- Santa Ana Public Library, Santa Ana, California.
Santa Barbara State College, 1920 Lausen Road, Santa Barbara, California.
Schortmann's Minerals, 6 McKinley Avenue, Easthampton, Massachusetts.
Science Museum Library, South Kensington, London, S.W. 7, England.
Scripps Institute of Oceanography Library, La Jolla, California.
Senores Banco Minero, Apartado Postal 2565, Lima, Peru.
Smith College Library, Northampton, Massachusetts.
Sociedad Científica Argentina, Santa Fe 1145, Buenos Aires, Argentina.
South Dakota State School of Mines Library, Rapid City, South Dakota.
Southbridge Technical Society, Jacob Edwards Library, Southbridge, Massachusetts.
Southern Methodist University, Library, Dallas, Texas.
Southwestern Louisiana Institute, Stephens Memorial Library, Lafayette, Louisiana.
Spencer Lens Company, Buffalo, New York.
Stanford University Library, Stanford University, California.
Standard Oil Company of New Jersey, Geological Department, 26 Broadway, New York, New York.
State University of Iowa Library, Iowa City, Iowa.
Stecher, G. E. and Company, Chemistry Department, 31 East 10 Street, New York, New York.
Steven, B. F. and Brown, 28-30 Little Russell Street, London, W.C. 1, England.
Syracuse University Library, Syracuse, New York.
- Tennessee Eastman Corporation, Kingsport, Tennessee.
Texas College of Mines and Metallurgy Library, El Paso, Texas.
Texas Technological College Library, Lubbock, Texas.
Thin, James, 54 South Bridge Street, Edinburgh, 1, Scotland.
Thomas and Hochwalt Laboratories, Monsanto Chemical Company, Dayton, Ohio.
Toledo Public Library, Toledo, Ohio.
Tufts College Library, Tufts College 57, Medford, Massachusetts.
- Union College Library, Schenectady, New York.
United States Bureau of Standards Library, Washington, D.C.
United States Geological Survey Library, Washington, D.C.
United States National Museum, Washington, D.C.
Universidad Nacional de Mexico Library, Calle del Lic. Verdad No. 2, Mexico City, D.F., Mexico.
University Library, Cambridge, England.
University, Department of Mineralogy and Petrology, Cambridge, England.
University Library, Stellenbosch, South Africa.
University Library, Adelaide, South Australia.
University College, Potchefstroom, Transvaal, South Africa.
University College of Swansea Library, Singleton Park, Swansea, England.
University of Arizona Library, Tucson, Arizona.
University of Arkansas, Fayetteville, Arkansas.
University of Berne, Mineralogical and Petrographical Institute, Berne, Switzerland.
University of British Columbia, Point Grey, British Columbia, Canada.
University of Brussels, Brussels, Belgium.
University of Buffalo Library, 3425 Main Street, Buffalo, New York.
University of Calcutta, Geological Department, Calcutta, India.
University of California Library, Berkeley, California.

- University of California, Division of Soils, 119 Hilgard Hall, Berkeley, California.
University of California at Los Angeles, Los Angeles, California.
University of Cape Town Library, Rondebosch, Cape Town, South Africa.
University of Chattanooga Library, Chattanooga, Tennessee.
University of Chicago Libraries, Chicago, Illinois.
University of Cincinnati, Director of Central Stores, Cincinnati, Ohio.
University of Cincinnati Library, Burnett Woods Park, Cincinnati, Ohio.
University of Colorado Library, Boulder, Colorado.
University of Connecticut Library, Storrs, Connecticut.
University of Hawaii, Honolulu, Hawaii.
University of Illinois Library, Urbana, Illinois.
University of Kansas Library, Lawrence, Kansas.
University of Kentucky Library, Lexington, Kentucky.
University of Liege, Geological Laboratory, Liege, Belgium.
University of Louvain Library, Place du People, Louvain, Belgium.
University of Manchester Library, Manchester, England.
University of Manitoba Library, Winnipeg, Manitoba, Canada.
University of Melbourne Library, Carlton N. 3, Victoria, Australia.
University of Michigan Library, Ann Arbor, Michigan.
University of Minnesota Library, Minneapolis, Minnesota.
University of Missouri Library, Columbia, Missouri.
University of Nebraska Library, Lincoln, Nebraska.
University of New Hampshire Library, Durham, New Hampshire.
University of New Mexico Library, Albuquerque, New Mexico.
University of North Carolina Library, Chapel Hill, North Carolina.
University of North Dakota Library, University, North Dakota.
University of Oklahoma Library, Norman, Oklahoma.
University of Oregon Library, Eugene, Oregon.
University of Pennsylvania Library, Philadelphia, Pennsylvania.
University of Pittsburgh Library, 310 State Hall, Pittsburgh, Pennsylvania.
University of Pretoria Library, Pretoria, South Africa.
University of Rochester Library, Rochester, New York.
University of St. Andrews Library, St. Andrews, Scotland.
University of Sheffield, St. George's Square, Sheffield 1, England.
University of South Carolina, Department of Geology, Columbia, South Carolina.
University of South Dakota Library, Vermilion, South Dakota.
University of Southern California Library, University Park, Los Angeles, California.
University of Sydney, Fisher Library, Sydney, New South Wales, Australia.
University of Texas Library, Austin, Texas.
University of Toronto Library, Toronto, Ontario, Canada.
University of Utah Library, Salt Lake City, Utah.
University of Virginia Library, Charlottesville, Virginia.
University of Washington Library, Seattle, Washington.
University of West Virginia Library, Morgantown, West Virginia.
University of Western Australia Library, Perth, Western Australia.
University of Wisconsin Library, Madison, Wisconsin.
University of Witwatersrand Library, Johannesburg, South Africa.
University of Wyoming Library, Laramie, Wyoming.

Vanadium Corporation of America Library, Bridgeville, Pennsylvania.
Vanderbilt University, Joint University Library, Nashville, Tennessee.
Victory Shipping Company, Maritime Building, 8-10 Bridge Street, New York, New York.

Ward's Natural Science Establishment, Rochester, New York.
Washington State College Library, Pullman, Washington.
Washington University Library, St. Louis, Missouri.
Wayne Laboratories, 17 East Main Street, Waynesboro, Pennsylvania.
Wellesley College Library, Wellesley, Massachusetts.
Wesleyan College Library, 175 North Street, Middletown, Connecticut.
Wichita City Library, Wichita, Kansas.

Yale University, Brush Mineralogical Library, Kirtland Hall, New Haven, Connecticut.
Young, Henry, and Sons, Ltd., 15 North John Street, Liverpool, England.

NOTES AND NEWS

MEASURING LINEAR STRUCTURES ON STEEP-DIPPING SURFACES

D. JEROME FISHER,

University of Chicago, Chicago, Illinois.

Ingerson¹ has recently described an "Apparatus for Direct Measurement of Linear Structures." In the course of this article he correctly states the method of obtaining by means of the meridian stereographic net the bearing (*B*) and pitch (*P*) of the lineation from (1) the dip (*D*) and strike (*S*) of the *s*-surface plus (2) the protractor angle (*A*) in the *s*-plane between its strike and the direction of lineation. He dislikes this procedure for a number of reasons, one of which is that "it does not give final measurements for comparison in the field."

The writer has recently described a new projection protractor² which takes the place of the ordinary protractor commonly carried by the field geologist. This new instrument is only about half again as large as the common 5-inch semi-circular protractor. By using the new stabilized tracing paper many stereographic problems including the one described by Ingerson can be solved above the semi-net of this protractor, and this is easily done right in the field.

As pointed out by Ingerson the problem of measuring linear structures in the field is not difficult as long as these lie in planes which do not dip steeply. If one meets many cases involving fairly high dips, it would be desirable to have the Ingerson apparatus, though this must be quite expensive. For those who cannot afford this, or for whom the problem is only an occasional one, the net solution approximately as given by Ingerson or the special protractor solutions described below may be of interest. The problem used is the same one stated by Ingerson, where $D = 70^\circ$ NE., $S = N. 56 W.$, and $A = 69^\circ$ (down to the NW.), and the projection is from the lower hemisphere.

¹ *Am. Mineral.*, **27**, 721-725 (1942).

² *Jour. Geol.*, **49**, 292-323, 419-442 (1941). Reprint, protractor, and paper are available from the Univ. of Chicago Bookstore.

*Stereonet Solution.*³ Place the projection protractor above a piece of $\frac{1}{4}$ " thick plywood on which rests a piece of white paper (or paint the plywood white).⁴ Place a piece of stabilized tracing paper above the semi-net and insert a fine needle⁵ through it and the center of the net C ⁶ into the plywood. Plywood and paper need be only slightly larger than the semi-net, but it is perhaps better to have the tracing paper slightly larger than the full net.

Draw a short arrow tick on the tracing paper above the north end of the polar diameter of the net and label it N . Rotate the paper so that N lies above $N. 56^{\circ} W$. Place a dot at point L along meridian 20° (out from center along equator) and 69° from N . Rotate the tracing paper until L lies above the polar diameter, when it is read that $LC = 29^{\circ} -$ and N lies 14° west of the polar diameter.

This method thus requires the location of one tick and one point together with two rotations. Really only one rotation is necessary, since the initial tick (N) may be drawn at $N. 56^{\circ} W$. The visualization of this particular problem is clearer if the S pole of the net is taken as the one near the center of the projection protractor, rather than the reverse as is done above. L is then established when the N tick on the tracing paper lies above $N. 56^{\circ} E$. of the net; this condition fits Ingerson's Fig. 1. LC is then read when N is above $N. 14^{\circ} E$.

³ A stereonet solution (upper hemisphere projection) is described in H. W. Fairbairn: *Structural Petrology of Deformed Rocks* (1942), pp. 106, 125.

⁴ Or make a positive cut film copy of a complete net (as suggested by Ingerson and Tuttle in the following paper) and cement its emulsion side to a $\frac{1}{8}$ -inch thick piece of white celluloid.

⁵ For convenience in carrying, my friend F. Paba has suggested that the needle may be mounted in the cap of a small metal box such as is supplied with extra leads for a mechanical pencil. First insert its eye end in a blob of soft glass; then cement this in the metal cap with plastic wood, sealing wax, or plaster of Paris.

⁶ Symbols are as in Fig. 2 on p. 296 of *Jour. Geol.*, **49**, 296 (1941), with N (north pole) just below the center of the projection protractor.

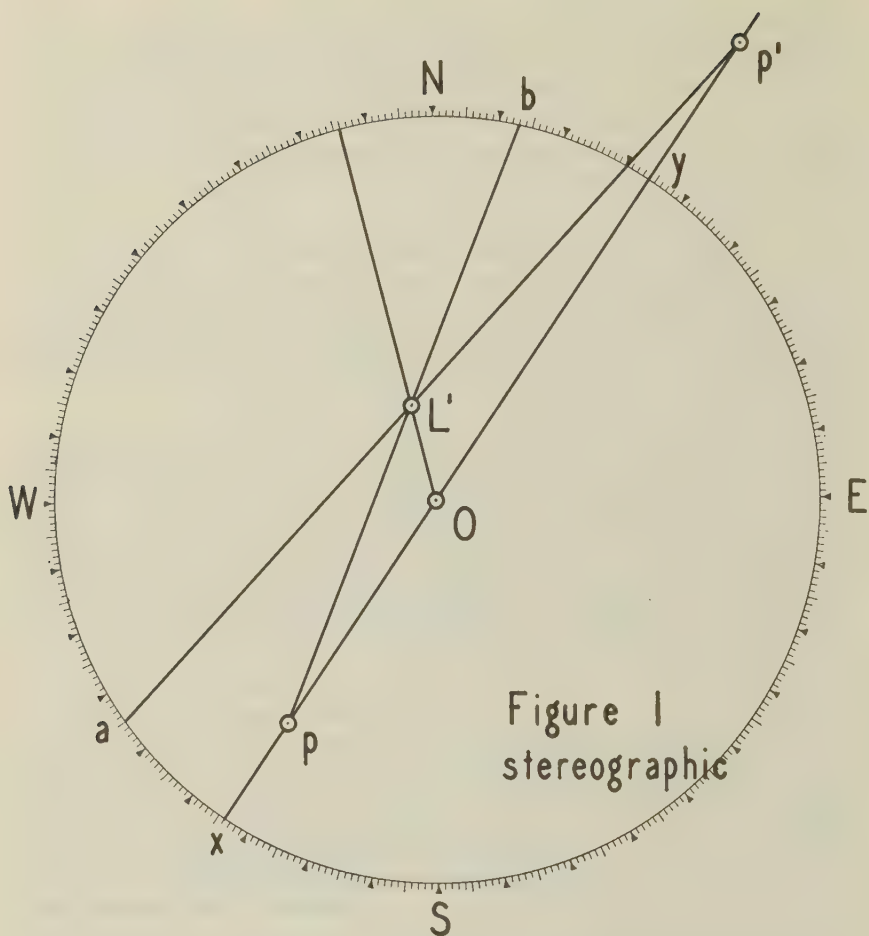


FIG. 1.

Alternative Stereographic Solution. Figure 1. Draw the diameter xy in the dip direction. With the top scale of the projection protractor along this, its zero-point at O , establish antipodal points p and p' such that $Op = D$ and $Op' = (180 - D) = 110^\circ$, the latter in the dip direction. Locate a and b on the protractor circle out from x and y by $(90 - A) = 21^\circ$. Draw pb and $p'a$ their intersection⁷ giving L' . Then the angle of pitch $P = (90 - OL') = 61^\circ +$ (read along the top scale of the projection protractor) and a radius through OL' gives the required bearing $B = N. 14^\circ W$.

⁷ Explanation of this method appears in Fisher, D. J., *op. cit.*, footnote 16.

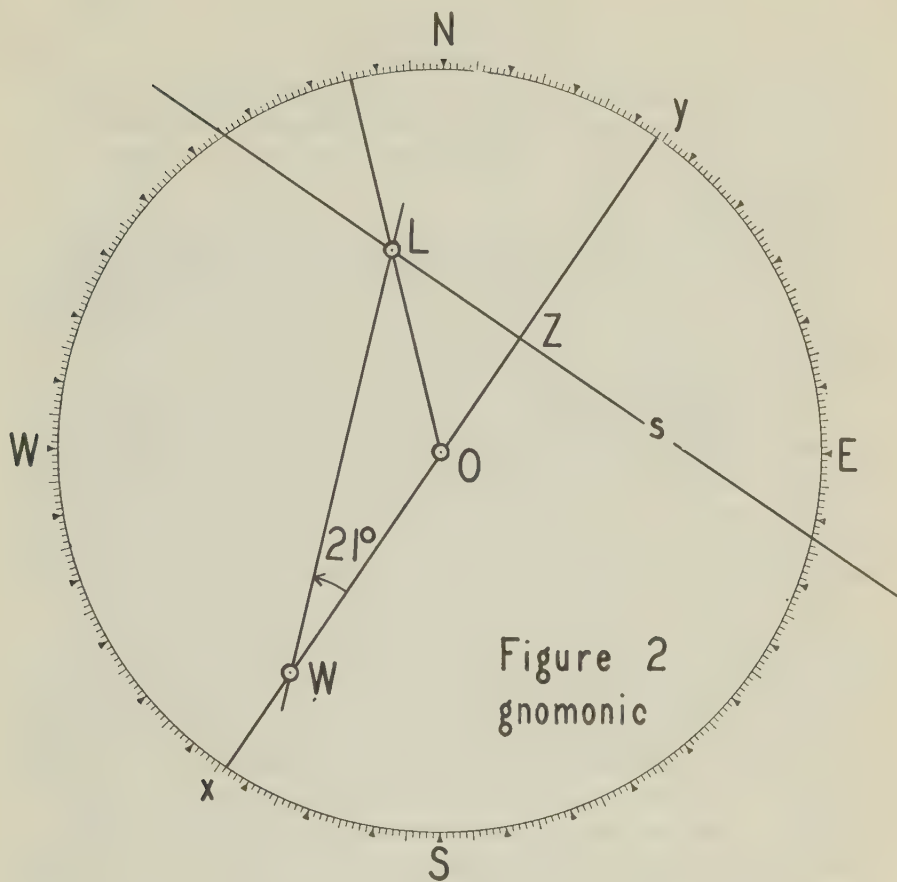


FIG. 2.

Gnomonic Solution. Figure 2. Draw the diameter xy in the dip direction. With the top scale of the projection protractor along this, its zero-point at O , establish W and Z such that $OW = D$ (measured in *stereographic* degrees) and $OZ = (90 - D) = 20^\circ$ (measured in *gnomonic* degrees in the direction of the dip). With a straight edge (or field scale) along xy , erect a normal to it at Z by using the projection protractor in lieu of a small right angle triangle. This line represents the euthygraphic projection of the s -surface, and W is its angle point. At W lay off an angle of $(90 - A) = 21^\circ = \angle ZWL$ which serves to establish L along line ZL . Then the angle of pitch $P = (90 - OL) = 61^\circ +$ (read in gnomonic degrees along the top scale of the projection protractor) and a radius through OL gives the required bearing $B = N. 14^\circ W$.

DISCUSSION

It is felt that the stereonet solution is definitely to be preferred to the alternative stereographic construction. However, the gnomonic solution, as is commonly the case, is considerably more accurate than the stereographic one; it also permits the easiest visualization of the problem, and so mistakes are less likely to occur.

If the geologist could go into the field knowing just what problems he would meet, for many cases he could take the necessary graphical solutions with him. Where the nature of his work is such that he expects to need to solve a certain equation many times, he does well to have with him the necessary graph or piece of apparatus to accomplish his purpose with a minimum consumption of time.

The advantage of projection solutions of problems involving angles between lines and planes is that they combine the clearness of descriptive geometry with the speed of the graphical solution. The user is not an automaton following a set routine; he is an artist visualizing what he is doing. Many problems can be done on a stereonet, and the small ones on positive film mentioned by Ingerson and Tuttle⁸ are satisfactory for field use. Where the greater accuracy that is generally inherent in gnomonic solutions is desired, the gnomonic scale of the projection protractor is essential. Those stereographic problems requiring the use of small circles⁹ cannot be done above a net, and are greatly facilitated by a stereoscale. For any one particular problem the stereonet or even the whole projection protractor may not offer the best solution, though the writer considers that it does in some cases, such as the two-tilt¹⁰ and two-borehole problems. When one takes into consideration the large numbers of problems that can be solved with this one piece of equipment, it seems that it should be in the outfit of every field geologist, especially since it replaces an ordinary protractor, as well as a small right-angle triangle and a centimeter scale.

⁸ See following paper.

⁹ Fisher, D. Jerome, Drillhole problems in the stereographic projection: *Econ. Geol.*, **36**, 551-560 (1941).

¹⁰ *Jour. Geol.*, **49**, 429 (1941).

A GRAPH FOR DETERMINING ANGLE AND DIRECTION OF PITCH OF LINEATIONS IN THE FIELD

EARL INGERSON AND O. F. TUTTLE,

*Geophysical Laboratory, Carnegie Institution of Washington,
Washington, D. C.*

Fisher¹ has outlined a field method of determining the direction and angle of pitch of lineations on steep-dipping surfaces. Dip and strike of the surface and the angle between the lineation and the strike in the *s*-plane are measured and a graphic solution is made with the aid of a combination stereographic net and protractor.² This projection protractor has the advantage of being much smaller than the stereographic net commonly used in a laboratory, but a photographic reproduction of a stereographic net can be made any size desired for inclusion in a field notebook. The ones in use at the Geophysical Laboratory are 50 to 100 mm. in diameter and are made on cut film.

These nets are not backed with white celluloid as suggested by Fisher, because it is convenient to be able to see through them for making measurements on diagrams on opaque paper.

If a lineation clinometer is not available, however, it is possible to use a graph³ from which the direction and angle of pitch can be determined from dip and strike of the *s*-plane, and the angle that the lineation makes with the strike in the *s*-plane, with no construction at all. Such a graph (Fig. 1) has been constructed from the following formulae:—⁴

$$(1) \sin P = \sin A \sin D$$

$$(2) \tan A' = \tan A \cos D$$

where:

P = pitch of lineation

A' = horizontal angle between strikes of *s*-plane and lineation

A = angle between lineation and strike of *s*-plane, measured in *s*

D = dip of plane containing lineation.

¹ Fisher, D. J., Measuring linear structure on steep-dipping surfaces: *Am. Mineral.*, **28**, 204–208 (1943).

² Fisher, D. J., A new projection protractor: *Jour. Geol.*, **49**, 292–323 and 419–442 (1941).

³ Suggested and constructed by Tuttle.

⁴ If a graph is not available, these formulae could be used in the field by carrying a condensed (1 page) table of the trigonometric functions (such as Appendix—Lahee, *Field Geology*, McGraw-Hill).

⁵ This angle must be added to, or subtracted from, the strike of the *s*-plane, of course, in order to get the direction of pitch of the lineation.

Using the same example that has been employed to illustrate the other methods,—*s*-plane N. 56° W. 70° NE., with lineation $\wedge$ strike 69° N.: Locate 70° on the horizontal coordinate and 69° on the vertical. Place a pencil on their intersection and read from the dashed curves $61^{\circ} + =$ pitch of lineation, and 42° from the solid curves. Direction of pitch is, therefore, N. 56° W. minus $42^{\circ} =$ N. 14° W.

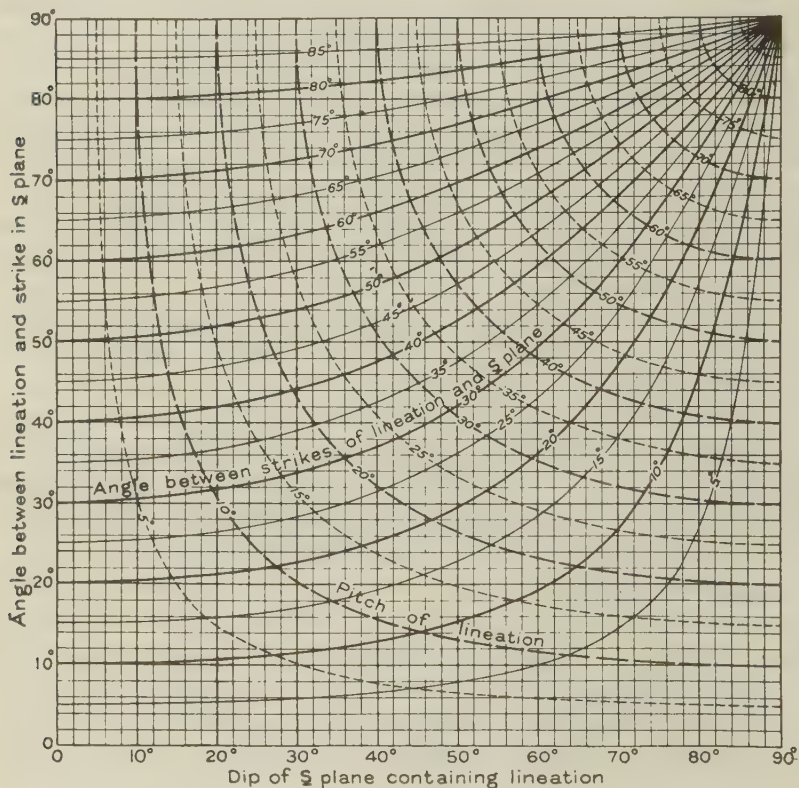


FIG. 1. Set of curves for determining direction and angle of pitch of a lineation from (1) dip and strike of an *s*-plane containing the lineation and (2) angle between strike and lineation in the *s*-plane. Dashed curves give angle of pitch, solid curves give horizontal angle between strike of the *s*-plane and direction of pitch of the lineation.

As pointed out in the description of the "lineation clinometer," when the dip of the *s*-plane is low, direct measurement with a Brunton compass is rapid and accurate enough for all practical purposes. When the *s*-plane and lineation are steep, however, the method using the graph described is much more accurate and takes very little more time.

PAPERS PUBLISHED IN THE BULLETIN OF THE GEOLOGICAL SOCIETY
OF AMERICA OF INTEREST TO READERS OF THE
AMERICAN MINERALOGIST

From time to time papers in the field of mineralogy and petrology appear in the *Bulletin of the Geological Society of America* which may be of interest to readers of *The American Mineralogist* who do not receive the publications of the Geological Society. For the benefit of these readers, the following list of available reprints is given. Any of these papers may be secured by writing to the Secretary of the Geological Society of America, 419 West 117 Street, New York, N. Y.

Volume 51, 1940

	PRICE
Granitization near Killarney, Ontario. By Terence T. Quirke, pp. 237-254.....	\$0.15
Fabric criteria for distinguishing pseudo ripple marks from ripple marks. By Earl Ingerson, pp. 557-570.....	0.10
Granites of the Front Range, Colorado: The Indian Creek plutons. By M. F. Boos and Esther Aberdeen, pp. 695-730.....	0.35
Petrographic province of central Montana. By Esper S. Larsen, pp. 887-948.....	0.30
Concentric patterns in the granites of the Llano-Burnet region, Texas. By David Keppel, pp. 971-1000.....	0.25
Experimental flow of rocks under conditions favoring recrystallization. By David Griggs, pp. 1001-1022.....	0.15
"Flow" in stressed solids: an interpretation. By Roy W. Goranson, pp. 1023-1034	0.10
Equilibrium between vapor and liquid phases in the system $\text{CO}_2\text{-H}_2\text{O-K}_2\text{O-SiO}_2$. By G. W. Morey and Michael Fleischer, pp. 1035-1058.....	0.10
Differentiation of the Palisade diabase. By Frederick Walker, pp. 1059-1106.....	0.30
Rock series in diabase sills at Duluth, Minnesota. By G. M. Schwartz and A. E. Sandberg, pp. 1135-1172.....	0.30
Tungsten-bearing manganese deposit at Golconda, Nevada. By P. F. Kerr, pp. 1359-1390.....	0.25
Studies of the Lake Superior pre-Cambrian by accessory-mineral methods. By S. A. Tyler, R. W. Marsden, F. F. Grout, and G. A. Thiel, pp. 1429-1538.....	0.65
Igneous rocks of the Terlingua-Solitario region, Texas. By J. T. Lonsdale, pp. 1539-1626.....	0.60
Audubon-Albion stock, Boulder County, Colorado. By Ernest E. Wahlstrom, pp. 1789-1820.....	0.25
Archean metaconcretions of Thunder Lake, Ontario. By F. J. Pettijohn, pp. 1841-1850.....	0.10

Volume 52, 1941

Radioactivity of rocks. By R. D. Evans and Clark Goodman, pp. 459-490.....	0.15
Age measurements by radioactivity. By Clark Goodman and R. D. Evans, pp. 491-544.....	0.30
Helium retention in common rock minerals. By P. M. Hurley and Clark Goodman, pp. 545-560.....	0.10
Cooling of the earth. By L. B. Slichter, pp. 561-600.....	0.20
Geology of the zinc-lead deposit on Calumet Island, Quebec. By W. W. Moorhouse, pp. 601-632.....	0.25
Mylonization of hybrid rocks near Philadelphia, Pennsylvania. By Elizabeth Arm-	

strong, pp. 667-694.....	0.30
Geology of the Stony Mountain stock, San Juan Mountains, Colorado. By McClelland Dings, pp. 695-720.....	0.20
Structure and petrology of the Boxelder laccolith, Bearpaw Mountains, Montana. By William T. Pecora, pp. 817-854.....	0.30
Structure and metamorphism in the Mount Washington area, New Hampshire. By Marland P. Billings, pp. 863-936.....	0.55
Flow cleavage in folded beds. By C. O. Swanson, pp. 1245-1264.....	0.10
Deformation lamellae in quartz from the Ajibik formation, Michigan. By H. W. Fairbairn, pp. 1265-1278.....	0.10
Petrography and origin of the Rex chert. By W. D. Keller, pp. 1279-1298.....	0.10
Protoclastic border of the Colville batholith. By A. C. Waters and Konrad Krauskopf, pp. 1355-1418.....	0.50
Formation of igneous-looking rocks by metasomatism; a critical review and suggested research. By Frank F. Grout, pp. 1525-1576.....	0.25
Igneous rocks of the Highwood Mountains	
Part II. The extrusive rocks. By E. S. Larsen, pp. 1733-1752.....	0.40
Part III. Dikes and related intrusives. By B. F. Buie, pp. 1753-1808.....	0.30
Part IV. The stocks. By C. H. Burgess, pp. 1809-1828.....	0.15
Part V. Contact metamorphism. By E. S. Larsen and B. F. Buie, pp. 1829-1840.....	0.10
Part VI. Mineralogy. By E. S. Larsen <i>et al.</i> pp. 1841-1856.....	0.10
Part VII. Petrology. By E. S. Larsen <i>et al.</i> pp. 1857-1868.....	0.10
(Part I. The laccoliths, by C. S. Hurlbut and David Griggs, appears in vol. 50, pp. 1043-1112, price \$0.60.)	

Volume 53, 1942

Genesis of some ore deposits of southeastern Maine. By Ching-Yuan Li, pp. 15-52.....	0.25
Stratigraphy, structure, and petrology of Mt. Cube area, New Hampshire. By J. B. Hadley, pp. 113-176.....	0.35
Mineralization in the West Tintic mining district, Utah, By B. F. Stringham, pp. 267-290.....	0.15
Phase petrology in the Cortlandt complex, New York. By S. James Shand, pp. 409-428.....	0.15
Alkaline and carbonate intrusives near Bancroft, Ontario. By Felix Chayes, pp. 449-512.....	0.30
Amphibolites of the Lead area, northern Black Hills, South Dakota. By Theodore A. Dodge, pp. 561-584.....	0.25
Spectroscopic distribution of minor elements in igneous rocks from Jamestown, Colorado. By Joseph M. Bray, pp. 765-814.....	0.30
Phosphorite deposits on the sea floor off southern California. By R. S. Dietz, K. O. Emery, and F. P. Shepard, pp. 815-848.....	0.30
Intrusive domes of the Claremont-Newport area, New Hampshire. By Carleton A. Chapman, pp. 889-916.....	0.20
Endomorphism of the Idaho batholith. By Alfred A. Anderson, pp. 1099-1126.....	0.25
Origin and structure of the Livingston igneous rocks, Montana. By Willard H. Parsons, pp. 1175-1186.....	0.10
"Pseudomigmatite" in the Piedmont of Maryland. By Randolph W. Chapman, pp. 1299-1330.....	0.25
Ring structures of the Pliny region, New Hampshire. By Randolph W. Chapman, pp. 1533-1568.....	0.25

BOOK REVIEW

ANNOTATED GEOLOGICAL BIBLIOGRAPHY OF VIRGINIA by JOSEPH K. ROBERTS. Published by the Alderman Library, Charlottesville, Virginia, 1942. xi+726 pages.

The author of this comprehensive work has been abstracting and assembling the geological literature of Virginia for a period of over twenty years. The results of this time-consuming effort are now made available through the publication of this volume of 726 pages. All phases of Virginia's geology are covered with the exception of soils and climate. The length of the abstracts varies with the character and importance of the article, but in all cases they seem entirely adequate, and are recorded without critical comments. The references which number 2568 entries are given by authors, alphabetically arranged.

While the annotated references end with the calendar year 1940, an additional abstract is appended of an article of special interest that appeared while the manuscript was in press. This article discusses the "Geology of the Appalachian Valley in Virginia." Of more than passing interest to mineralogists is the inclusion of statistics on the mineral resources of Virginia, given on pages 418 to 445 of the report.

In addition to the titles of papers, references and abstracts, two quite unusual and interesting chapters are included. One discusses the "Rise and Development of Geological Thought in Virginia." Here the author distinguishes four periods: Colonial Period, up to 1835; Rogers Period, 1835-1880; Fontaine-Campbell Period, 1880-1910; and the Watson Period, 1910 to the present. The other chapter records biographical sketches of nine geologists who have made major contributions to Virginia's geology.

Dr. Roberts is to be congratulated on the completion of this splendid work. Students of Virginia geology will find it a great time-saver and therefore indispensable as the abstracts are given in sufficient detail as to make consultation of the original papers unnecessary, in most instances.

W. F. H.

NEW MINERAL NAMES

Hochschildite

ROBERTO HERZENBERG: Hochschildita, un nuevo mineral de estano descubierto en Bolivia. Reprint of abstract of paper given at the University of Oruro, Sept. 25, 1942.

NAME: For Dr. Mauricio Hochschild.

CHEMICAL PROPERTIES: Four complete analyses (not given) were made on selected material. The average of these analyses, after deduction of 0.7% S, 0.2% Sb, and 0.043% Ag, and recalculation to 100%, was: SnO_2 47.75, PbO 28.6, Fe_2O_3 8.05, SiO_2 4.37, H_2O 11.23%. This gives molecular ratios: SnO_2 5.05, PbO 2.05, Fe_2O_3 1, SiO_2 1.14, H_2O 9.87. The formula suggested is $5\text{SnO}_2 \cdot 2\text{PbO} \cdot \text{Fe}_2\text{O}_3 \cdot \text{SiO}_2 \cdot 10\text{H}_2\text{O}$ or $2\text{PbSnO}_3 \cdot \text{Fe}_2(\text{SnO}_3)_3 \cdot \text{H}_2\text{SiO}_3 \cdot 9\text{H}_2\text{O}$. As the material is visibly variable, it is suggested that the Fe_2O_3 and SiO_2 are impurities and that the formula may be $\text{PbSnO}_3 \cdot n\text{H}_2\text{O}$, with $n = 5-6$. The water content is variable and the mineral loses its water gradually on being heated, like a typical gel. It is infusible. The fresh mineral is soluble in HCl, leaving a small residue of cassiterite and quartz, and is partially soluble in acetic acid. All the tin and lead is dissolved by NaOH or KOH. Ignition renders the mineral insoluble in HCl; heating to 100° makes it partially insoluble. Heated on charcoal, the mineral gives a coating of lead and tin oxides.

PHYSICAL AND OPTIONAL PROPERTIES: Color yellow. Earthy. Under the microscope clear yellow, isotropic, n slightly higher than nitrobenzene ($n = 1.55$). $G. = 4.45-4.59$. Hardness = 3, or slightly higher. Friable.

OCCURRENCE: Occurs as pseudomorphs after teallite in the oxidation zone of the Ichu-colla mine, Callipampa, Bolivia. Sometimes contains unoxidized remnants of teallite. Associated minerals are cerussite and hydrated iron oxide.

RELATIONSHIPS: A relationship to bindheimite is suggested.

DISCUSSION: Further study, particularly x-ray examination, is needed.

MICHAEL FLEISCHER

Sampleite

C. S. HURLBUT, JR.: *Am. Mineral.*, **27**, 586-589 (1942).

Cryptomelane

W. E. RICHMOND AND M. FLEISCHER: *Am. Mineral.*, **27**, 607-610 (1942).

L. S. RAMSDELL: *Am. Mineral.*, **27**, 611-613 (1942).

DISCREDITED SPECIES

Berthonite (= Bournonite)

G. A. HARCOURT: *Am. Mineral.*, **27**, 109 (1942).

Ramdohrite (= Andorite)

G. A. HARCOURT: *Am. Mineral.*, **27**, 109 (1942).

Beegerite (= Schirmerite + Matildite)

G. A. HARCOURT: *Am. Mineral.*, **27**, 109 (1942).

Ascharite, β -Ascharite, Camsellite (= Szaibelyite)

W. T. SCHALLER: *Am. Mineral.*, **27**, 467-486 (1942).

Illite (= Bravaisite)

R. E. GRIM AND R. A. ROWLAND, *Am. Mineral.*, **27**, 810, 817 (1942).

Dillnite, Severite (= Kaolinite)

R. E. GRIM AND R. A. ROWLAND: *Am. Mineral.*, **27**, 814 (1942).

M. F.

Dr. Albert B. Peck, professor of mineralogy at the University of Michigan, died suddenly at his home on Saturday, Feb. 13, at the age of fifty years. Dr. Peck was a charter fellow of the Mineralogical Society of America and served as treasurer from 1920-1923; 1929-1930; also as secretary of the Society from 1933-1934.

Dr. William S. Bayley, since 1931 professor emeritus of geology at the University of Illinois, died on Feb. 14, at the age of eighty-one years. From 1931-1934 Professor Bayley served on the Council and in 1936 was elected president of the Mineralogical Society of America.